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Geologic and Hydrologic Research at the Western New York Nuclear Service Center West Valley, New York

Progress Report
August 1979 - July 1981

Prepared by J. R. Albanese, L. A. Dunne, W. B. Rogers, S. M. Potter

New York State Geological Survey/State Museum
New York State Education Department

Prepared for
U.S. Nuclear Regulatory Commission

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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
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ABSTRACT

This is a report of the progress made during the first part of a proposed multi-year program of geologic and hydrologic investigations at the Western New York Nuclear Service Center. The New York State Geological Survey previously worked (1975-1979) on a small part of this area, specifically that of the New York State-licensed radioactive waste burial trenches. During the latest reporting period a large scale topographic map of the 140 hectare site immediately surrounding the nuclear fuel reprocessing plant has been produced, and three additional permanent stream stations have been installed to allow monitoring of most runoff from the site. Ten holes drilled in the North Plateau determined the geometry of the surficial gravel deposits there. A system of ground-water monitoring wells was established in these holes. The second phase of the geomorphic investigations of the Buttermilk Creek drainage basin and a study of the effect of submergence on the geotechnical properties of the burial till were completed.

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CONTENTS

Abstract iii
List of Figures vii
List of Tables ix
Acknowledgements xi
List of Abbreviations xiii

1.0 INTRODUCTION 1
2.0 PURPOSE OF STUDY 3
3.0 SCOPE OF STUDY. 4
4.0 CONCLUSIONS 5
5.0 RECOMMENDATIONS 7
6.0 GEOLOGICAL SETTING 9
6.1 Paleozoic Geology 9
6.2 Pleistocene Geology 9
6.3 Holocene Geology 10
7.0 GEOLOGIC INVESTIGATIONS 12
7.1 Topographic Mapping 12
7.2 Stratigraphic Interpretations 12
8.0 GEOMORPHIC INVESTIGATIONS 23
9.0 GEOTHCHNICAL INVESTICATIONS 26
10.0 SURFACE WATER INVESTIGATIONS 28
11.0 SUMMARY 42
12.0 REFERENCES 45

APPENDIXES

A. Reports of Studies by the New York State Geological Survey at the WNYNSC 49
B. Proposed Deep Drilling Program 54
C. Geologic Logs of Wells Drilled During the 1980 Drilling Program . . 57
D. Radiochemical Analyses of Water Samples Collected from the Lagoon Road, Swamp, and Frank's Creek Stream Monitoring Stations . . 90
E. Radiochemical Analyses of Sediment Samples Collected from the Lagoon Road, Swamp, and Frank's Creek Stream Monitoring Stations . . . 97

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LIST OF FIGURES

Figure #		Page #
1	Map of a Portion of the Western New York Nuclear Service Center Showing the Locations of the Nuclear Fuel Reprocessing Plant; the NYS Burial Trenches, the NRC Burial Area, and other Geographical Features	2
2	Isopach Map of the Holocene Alluvial Fan Deposit on the North Plateau Showing Aerial Extent and Thickness	11
3	Aerial Photograph of a Portion of the Western New York Nuclear Service Center Showing the Approximate Extent of Detailed Topographic Mapping	13
4	Generalized North to South Geologic Cross Section through a Portion of the Western New York Nuclear Service Center	14
5	Generalized East to West Geologic Cross Section through a Portion of the Western New York Nuclear Service Center	15
6	Map of a Portion of the Western New York Nuclear Service Center Showing the Locations of the Generalized Geologic Cross Sections	16
7	Map of a Portion of the Western New York Nuclear Service Center Showing the Locations of Wells Drilled During the 1980 Drilling Program	17
8	Map of the Western New York Nuclear Service Center Illustrating the Drainage Basin of the Buttermilk Creek	24
9	Map of a Portion of the Western New York Nuclear Service Center Showing the Location of the Research Trench Examined during the Geotechnical Investigation	27
10	Map of a Portion of the Western New York Nuclear Service Center Showing the Drainage Basins Monitored by the Lagoon Road, Swamp, and Frank's Creek Stream Stations	29
11	Map of a Portion of the Western New York Nuclear Service Center Showing the Drainage Basins monitored by Stream Stations NP1, NP3, and Burial 1	30

List of Figures (CON'D.)

Figure #		Page #
12	Map of a Portion of the Western New York Nuclear Service Center Showing the Locations of Rain Gages and Stream Monitoring Stations	32
13	Diagrammatic Representation of the Stream Stations Installed During 1980	33
14	Map of a Portion of the Western New York Nuclear Service Center showing the Tentative Locations of the Propesed Deep Drilling	56
15	Geological Log of Core 80-1	58
16	Geological Log of Core 80-2	62
17	Geological Log of Core 80-3	65
18	Geological Log of Core 80-4	67
19	Geological Log of Core 80-5	69
20	Geological Log of Core 80-6	71
21	Geological Log of Core 80-7	74
22	Geological Log of Core 80-8	76
23	Geological Log of Core 80-9	80
24	Geological Log of Core 80-10	84
25	Key to Geological Logs	89

LIST OF TABLES

Table #		Page #
1	Summary of the 1980 Drilling Program	18
2	Radiochemical Analyses of Sediment Samples Collected During the 1980 Drilling Program	20
3	Radiochemical analyses of Water Samples Collected During the 1980 Drilling Program	22
4	Precipitation at Raingage #1, WNYNSC, West Valley, New York from 12/31/79 through 11/10/80	34
5	Precipitation at Raingage #2, WNYNSC, West Valley, New York from 12/31/79 through 11/10/80	36
6	Background Radiochemical Analyses of Water Samples Collected from Buttermilk Creek, May 5, 1980	38
7	Surface Water Monitoring and Sampling Program Outline	40
8	Geologic Log, Core 80-1	60
9	Geologic Log, Core 80-2	63
10	Geologic Log, Core 80-3	66
11	Geologic Log, Core 80-4	68
12	Geologic Log, Core 80-5	70
13	Geologic Log, Core 80-6	72
14	Geologic Log, Core 80-7	75
15	Geologic Log, Core 80-8	78
16	Geologic Log, Core 80-9	82
17	Geologic Log, Core 80-10	86
18	Radiochemical Analyses of Water Samples Collected from Frank's Creek	91
19	Radiochemical Analyses of Water Samples Collected from Lagoon Road	93
20	Radiochemical Analyses of Weekly Composite Water Samples Collected from Lagoon Road	94
21	Radiochemical Analyses of Water Collected During Low and Base Flow Conditions at Lagoon Road	95
22	Radiochemical Analyses of Water Samples Collected at the Swamp Monitoring Station	96
23	Radiochemical Analyses of Sediment Samples Collected from Frank's Creek	98

LIST OF TABLES (CON'D.)

Table #		Page #
24	Radiochemical Analyses of Sediment Samples Collected from Lagoon Road	100
25	Radiochemical Analyses of Weekly Composite Sediment Samples Collected from Lagoon Road	101
26	Radiochemical Analyses of Sediment Samples Collected During Low and Base Flow Conditions at Lagoon Road	102
27	Radiochemical analyses of Sediment Samples Collected at the Swamp Monitoring Station	103

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LIST OF ABBREVIATIONS

BP	years before present
ENCON	New York State Department of Environmental Conservation
km	kilometers
m	meters
NYSERDA	New York State Energy Research and Development Authority
NYSGS	New York State Geological Survey
pCi/g	picocuries ($_{10}$-12 curies) per gram
pCi/l	picocuries ($_{10}$-12 curies) per liter
RSL	Radiological Sciences Laboratory of the New York State Department of Health
USGS	United States Geological Survey -- Water Resources Division
USNRC	United States Nuclear Regulatory Commission
WNYNSC	Western New York Nuclear Service Center

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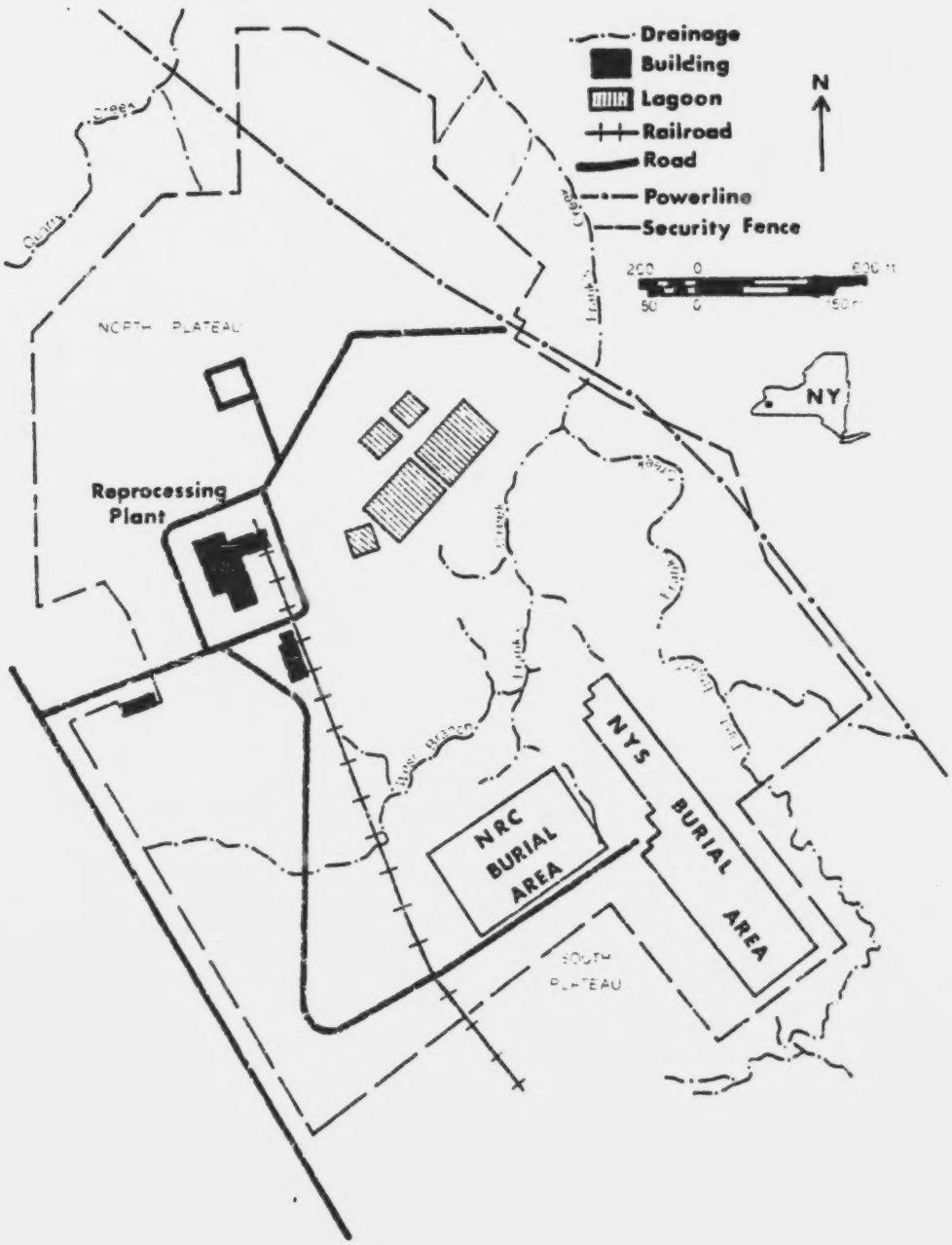
1.0 INTRODUCTION

The Western New York Nuclear Service Center (WNYNSC) is located in West Valley, Cattaraugus County, 48 km southeast of Buffalo, New York. Centrally located within this 1354 hectare property is a nuclear fuel reprocessing plant which stopped operations during 1975. Immediately to the north of the plant are two underground storage tanks filled with liquid radioactive waste. South of the plant is a burial area for highly radioactive solid waste licensed by the United States Nuclear Regulatory Commission (USNRC). A commercial, New York State-licensed, burial ground for waste with low radioactivity is also located on the southern area of the site. The locations of these areas are illustrated in Figure 1, a map of the approximately 140 hectare secure area within the WNYNSC property.

The New York State Geeological Survey (NYSGS) had been the lead agency in an interdisciplinary research program including geologic, geomorphic, surface and groundwater investigations since 1975. These investigations have involved the cooperation of many agencies in both the state and federal governments. These agencies have included the New York State Department of Health, New York State Department of Environmental Conservation (ENCON), New York State Energy Research and Development Authority (NYSERDA), and the United States Geological Survey (USGS). Studies of the Western New York Nuclear Service Center were initially funded by the United States Environmental Protection Agency (USEPA), then jointly by the USEPA and the United States Nuclear Regulatory Commission (USNRC), and then solely by the USNRC. These earlier studies focused on the New York State-licensed burial trenches and any potential pathways of radionuclide migration from this area. A list of reports that resulted from these NYSGS studies can be found in Appendix A.

This report deals with the first part of a proposed multiyear program designed to understand the geologic characteristics and processes of this part of New York State. The program goals are to evaluate the adequacy of the burial sites at West Valley for their containment of radioactive wastes, and to establish their expected natural life span. Expanding on former studies, this research will define the geologic and hydrologic characteristic of the WNYNSC site including the South Plateau, the area including the NYS burial area and the NRC burial area and the entire North Plateau and surrounding area. The presently funded part of this project has collected data for the evaluation of the geologic and hydrologic properties of the entire site.

Figure 1. Map of a portion of the Western New York Nuclear Service Center showing the locations of the nuclear fuel reprocessing plant, the NYS burial trenches, the NRC burial area, and other geographical features.



2.0 PURPOSE OF STUDY

During August 1979, the NYSGS began the first part of a USNRC-funded study of 1354 hectare of the Western New York Nuclear Service Center. The goal of this study is to learn enough about the natural processes at work to evaluate the adequacy of the present containment capabilities and the probable life span of the radioactive waste burial sites at West Valley. This study will define the surface and subsurface geologic and hydrologic characteristics of these sites and the surrounding areas to determine the potential for radionuclide migration off site.

This broader study is a logical extension of the studies done by the NYSGS which focused on the New York State-licensed burial trenches.

As in the past, the NYSGS is cooperating with the USGS, which is investigating site hydrology and handling the logistics of the drilling programs, and the Radiological Sciences Laboratory of the New York State Department of Health (RSL) which is providing the radiochemical analyses of water and sediment samples.

The integration of the information generated by each of these studies forms the basis of this first phase of the site-wide investigation. As this investigation continues an overview of the North Plateau area which contains the underground high-level radioactive liquid waste storage tanks and the NRC burial area will emerge. This will result, when combined with earlier studies, in a complete geologic and hydrologic characterization of the area occupied by the Western New York Nuclear Service Center.

3.0 SCOPE OF STUDY

Administratively this study has been divided into five interrelated areas of investigation. The areas and their work elements are as follows:

- 3.1 Geologic Investigation
  - 3.1.1 Topographic Mapping
  - 3.1.2 Stratigraphic Interpretation
- 3.2 Geomorphic Investigation
  - 3.2.1 Sedimentation in the NFS reservoirs
  - 3.2.2 Sediment and Clast Transport in the Buttermilk Creek Drainage Basin
  - 3.2.3 Landslide Processes
- 3.3 Geotechnical Investigation
  - 3.3.1 Measurement of the Effects of Long Term Submergence on the Engineering Properties of the Burial Till
- 3.4 Surface Water Investigation
  - 3.4.1 Precipitation Measurement
  - 3.4.2 Stream Runoff Monitoring for the Measurement of Discharge, Stage, and Suspended Sediment Concentrations
- 3.5 Radionuclide Analyses
  - 3.5.1 Sediment Samples Obtained from Drilling Program
  - 3.5.2 Groundwater Samples Obtained from Wells
  - 3.5.3 Surface Water Samples for Both Dissolved and Suspended Species
- 3.6 Groundwater Investigation
  - 3.6.1 Modeling of Groundwater Flow Patterns (This research will be undertaken in cooperation with the United States Geological Survey and reported on by them.)

4.0 CONCLUSIONS

This initial phase of geologic and hydrologic investigations of the 1354 hectare area occupied by the WNYSC has established a framework upon which final recommendations may be based. This framework will also be used to support a cohesive interpretation of the data collected. During this initial investigation, five tasks have been accomplished in the construction of this framework.

4.1 A large scale (1:100), detailed (contour interval of two feet), topographic map of the 140 hectare secure area has been produced for use as the base map for the investigation.

4.2 Three new stream monitoring stations have been emplaced in a cooperative effort with the USGS. These stations:

- 4.2.1 expand the pre-existing network to allow monitoring of runoff from most of the total area occupied by the site
- 4.2.2 are equipped with improved automatic sampling equipment to capture runoff more effectively, including storm events
- 4.2.3 were positioned using new siting techniques and obtain winter samples by maintaining a section of ice-free channel under each station.

4.3 A site-wide drilling program has been completed. This cooperative program with the USGS consisted of the drilling of ten new wells to:

- 4.3.1 establish the geometry of the surficial gravel deposit on the North Plateau area of the site
- 4.3.2 install a ground water monitoring system for the North Plateau area
- 4.3.3 provide additional stratigraphic information on a site-wide basis
- 4.3.4 obtain samples of soil and groundwater for radionuclide analyses.

4.4 The second phase of geomorphic investigations of the Buttermilk Creek drainage basin has been completed. This research, summarized in Section 8.0 and detailed in Boothroyd and others (1981), found:

4.4.1 there is significant clast movement in response to annual flood events in the Buttermilk Creek

4.4.2 down-slope movement of the valley wall material is a continuous process of generally small contribution to overall derudation of the area

4.4.3 suspended sediment discharge contributes two-thirds of the estimated yearly erosional volume

4.4.4 the overall denudation rate can be estimated at 6600 cubic meters annually.

4.5 After two years of submergence in a research trench, a geotechnical analysis was made of selected soil samples. This testing was to estimate any alteration of engineering properties of the burial till as a result of the flooded condition. It was found, and reported in Hoffman and others (1980), that:

4.5.1 there was some increase in soil moisture content

4.5.2 when compared with equivalent soil samples from an earlier study (Fickies et al. 1979) the unit weight of the soil had decreased

4.5.3 the prediction of these alterations, based on the fresh samples in the earlier study, was confirmed.

5.0 RECOMMENDATIONS FOR FUTURE PROGRAMS OF THIS STUDY

5.1 The drilling of several deep wells, as previously proposed by the NYSGS and USGS, is to provide information on the lithology and the deep geohydrologic regime. Tentative locations for these deep wells have been established (Appendix B).

5.2 Continuation of the geomorphic studies or the Buttermilk Creek drainage basin (after Boothroyd et al., 1979, 1981) to:

- 5.2.1 measure the spring freshet water and sediment discharges
- 5.2.2 obtain ages for Buttermilk Creek terrace levels
- 5.2.3 continue to monitor clast movement in Buttermilk Creek and initiate similar studies in Frank's Creek
- 5.2.4 study the Buttermilk Creek's delta in Cattaraugus Creek
- 5.2.5 construct longitudinal profiles of Quarry Creek and the West Branch of Frank's Creek.

5.3 A study of the sediment in the area behind the Springville Dam, which is downstream of the site, to determine its volume and the rate of sedimentation.

5.4 A wide area landslide study to estimate rates of general downslope movement. This study would involve the measurement of hillslope angles, determination of the lithology of the sliding units, characterization of tree growth forms, and surveys to measure the size and shape of previous slides.

5.5 Sedimentological and petrological studies to establish a classification scheme, based on lithologic characteristics, of the geologic units found on site and in the general area.

5.6 The construction of a Holocene map to identify currently operating geological processes to compare with the glacial geology maps of the area.

5.7 Installation of additional surface water monitoring stations on the Thomas Corners Road Bridge and the Frank's Creek railroad bridge to measure water and sediment discharges from these drainage basins.

5.8 Investigation of the acquisition of improved automatic stream monitoring equipment as the harsh weather and remote location of the stream stations make low maintenance, high reliability equipment necessary.

5.9 A study of the erosional history of the Cattaraugus Creek as a basis of predictions of local changes in base level.

5.10 The placement of additional rain gages to include the entire drainage basin in the area being monitored.

5.11 A geophysical survey using resistivity and seismic techniques to augment the present subsurface data for stratigraphic interpretation and to delineate landslide units.

5.12 An analysis of sediment samples for pollen to use for age determination and climatic conditions interpretation.

6.0 GEOLOGIC SETTING

6.1 Paleozoic Geology

The Western New York Nuclear Service Center lies in the glaciated Allegheny section of the Appalachian Plateau physiographic province. The regional bedrock is Late Devonian and older with the site immediately underlain by shales and sandstones of the Canadaway and Conneaut Groups (Rickard and Fisher, 1970). The bedrock is relatively undeformed and forms a shallow, southern-dipping monocline. Bedrock exposures are sparse and limited to discontinuous ledges at higher elevations or gorges cut by Pleistocene and Holocene fluvial systems.

There are no major folds or faults recognized in the site bedrock. Historically, the area has evidenced minor seismic activity. Dames and Moore (1970) believe that the strongest ground motion that would be experienced at the site would not exceed Intensity IV. The only significant structural feature in the site vicinity (37 km to the east) is the isolated, north-south trending Clarendon-Linden Structure (Chadwich, 1920; VanTyne, 1975; Fakundiny et al., 1978).

The preglacial topography was an upland dissected by deeply incised valleys. Valley entrenchment occurred during episodic periods of regional uplift. This uplift caused a reversal in drainage direction from the initial southward to present, northwest drainage system (Calkin and Muller, 1980). The valleys were subsequently infilled with a maximum of 180 m of Pleistocene and Holocene sediments. Depth to bedrock in the vicinity of the site varies from several meters to 150m (Nuclear Fuel Services, 1962; Calkin et al., 1974; Randall, 1980).

6.2 Pleistocene Geology

Marginal oscillations of the Pleistocene continental ice sheet produced sequences of different kinds of glacial deposits which veneer the preglacial surface. Detailed descriptions and interpretation of the glacial deposits in the site vicinity are discussed in Muller, 1977; Dana et al., 1979; LaFleur, 1979, 1980. Types of deposits described are interbedded lodgement, ablation, and morainal till, proglacial lacustrine, and outwash.

Illinoian-age glacial deposits are poorly exposed but several lines of evidence indicate an extensive pre-Wisconsinan glaciation history (MacClintock and Apfel, 1944; Calkin et al., 1974; Muller, 1975).

Muller (1975) identified four Wisconsinan glacial advances based on deposits in Cattaraugus County. From oldest to youngest, the deposits include the Olean, Kent, Defiance, and Valley Head Moraines. The Olean is correlated with the middle Wisconsinan (Altonian) Titusville glaciation in Pennsylvania (Muller, 1977). The subsequent galciations are late Wisconsinan (Woodfordian) in age. Olean and Kent ice covered the entire land surface whereas the Defiance and Valley Heads ice occupied only lower elevations within valley walls.

The Western New York Nuclear Service facilities lie on and in deposits of the Lavery till complex of the Defiance glaciation. The deposit comprises a clayey, silt till with minor amounts of deformed lacustrine clay and silt. LaFleur (1979) recognizes three interbedded subfacies within the Lavery till. Comprehensive descriptions of the Lavery till are given in Whitney, 1977; LaFleur, 1979, 1980a, b; Fickies et al., 1979; Fakundiny et al., 1980; Hoffman et al., 1980.

6.3 Holocene Geology

Development of the Holocene landscape has been controlled by fluvial and mass wasting processes (Boothroyd et al., 1979, 1981).

Drainage from upland areas, after deglaciation, deposited sand and gravel alluvial fans on the older glacial deposits. One of these fan deposits form the surface of the North Plateau area of the WNYNSC facility (Figure 2). A series of small fans are also developed along the low terraces of the Buttermilk Creek.

The drainage pattern of Buttermilk Creek and its tributaries, was developed during the late-glacial meltwater drainage with its initial incision occuring prior to 9920±240 BP (Boothroyd et al., 1979). Fluvial sedimentation is accomplished by bed- and suspended-load transport with the highest rates related to flood events. A series of fluvial terraces have been created as the Buttermilk downcut and widened its valley by lateral migration of the channel. Mass wasting in the Lavery deposits exposed along valley walls is widespread (LaFleur, 1979; Boothroyd et al., 1979, 1981). Soil creep, earth flow, and slump block sliding enhance widening of the stream valleys.

Figure 2. Isopach map of the Holocene alluvial fan deposit on the North Plateau showing areal extent and thickness.

7.0 GEOLOGIC INVESTIGATIONS

7.1 Topographic Mapping

A base map suitable for detailed geologic work for the entire WNYNSC site was obtained on contract from Erdman Anthony Associates of Rochester, New York. This is a topographic map at a scale of 1:100 with a two-foot contour interval compiled from aerial photography flown during May 1980 (Figure 3). The boundaries of the NYS and NRC burial areas were surveyed in January 1981. This topographic map of the approximately 140 hectare security area surrounding the nuclear fuel reprocessing plant has proven detailed enough to serve as a base map for the project. The aerial photographs have also been enlarged to the map's scale for use in the field to plot locations with maximum accruacy. All wells for which we have subsurface data have been plotted on this topographic map.

7.2 Stratigraphic Interpretations

The locations of wells have been plotted on the base topographic map, preliminary cross sections of the geology are being compiled. Although this work is still incomplete, our understanding of the subsurface is increasing with the production of each section. These geologic sections (Figure 4 and 5) are keyed to the map, illustrated in Fugure 6 to allow a general three dimensional stratigraphy of this area to be visualized.

The detail of these cross sections is enhanced by the drilling of ten new holes during the fall of 1980 as part of our cooperative program with the USGS. A summarey of the wells drilled as part of this program is described in Table 1.

The locations of these wells were chosen by the USGS and NYSGS in cooperation with Nuclear Fuel Services (NFS) personnel, the site operator, to assure the satisfaction of all parties, each with a different interest, in the drilling program. The final well locations are shown on Figure 7 as are the three surface sampling locations.

The major purpose of the drilling was to establish the geometry of the North Plateau surficial gravel and to install a groundwater monitoring system and thus define the groundwater movement and identify possible radionuclide migration through the upper layers of sediment of the North Plateau. The North Plateau area (Figure 1) differs geologi-

Figure 3. Aerial photograph of a portion of the Western New York Nuclear Service Center showing the approximate extent of the detailed topographic mapping.

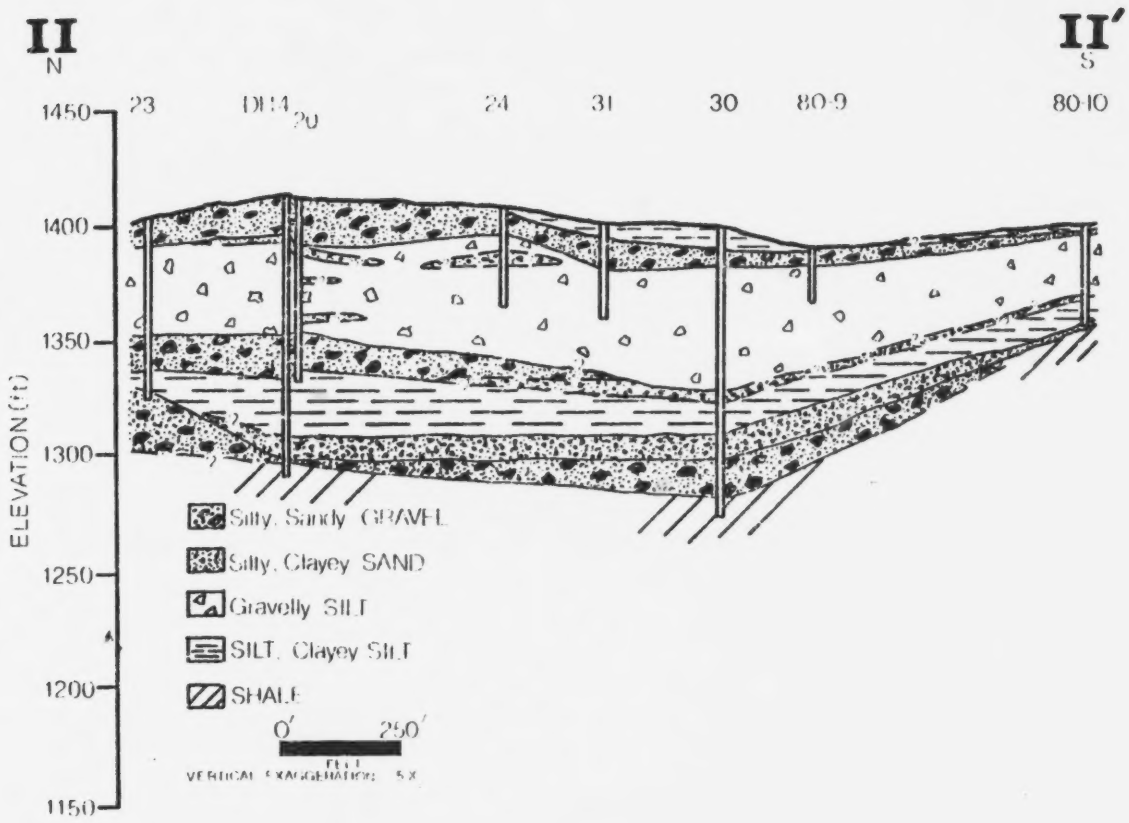


Figure 4. Generalized North to South geologic cross section through a portion of the Western New York Nuclear Service Center.

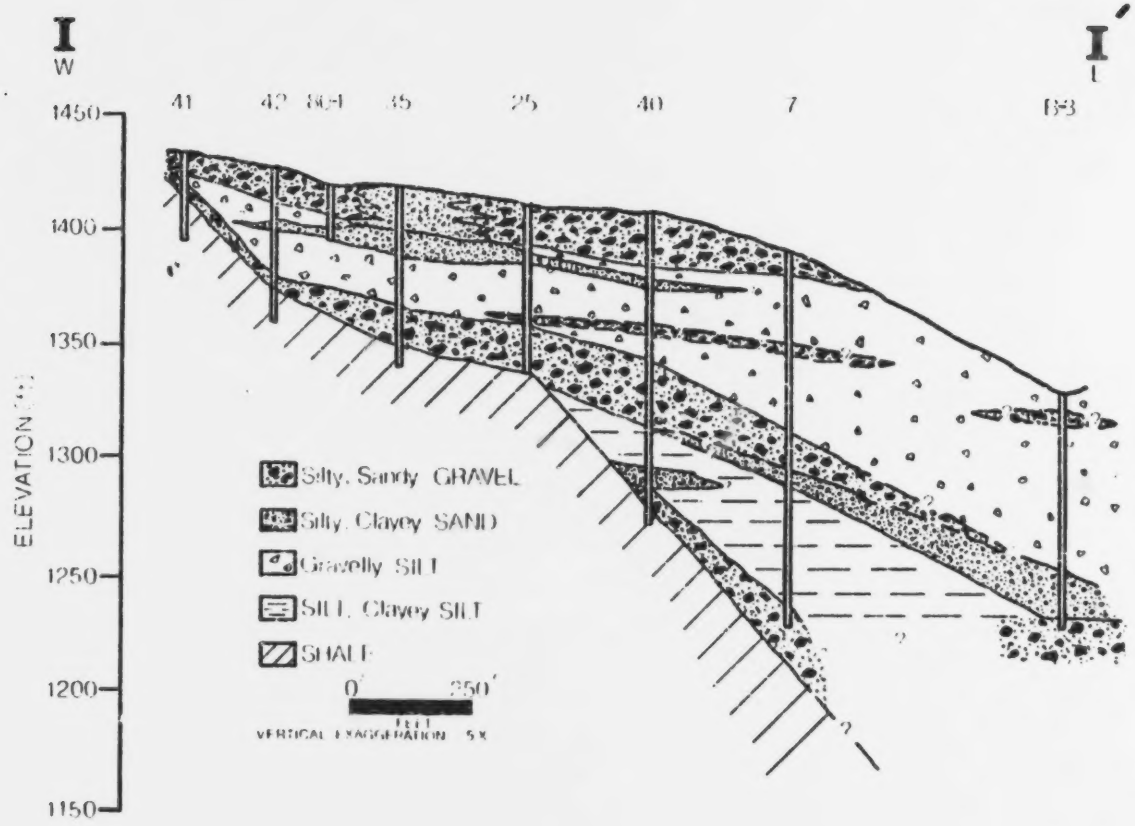


Figure 5. Generalized East to West geologic cross section through a portion of the Western New York Nuclear Service Center.

Figure 6. Map of a portion of the Western New York Nuclear Service Center showing the locations of the generalized geologic cross sections.

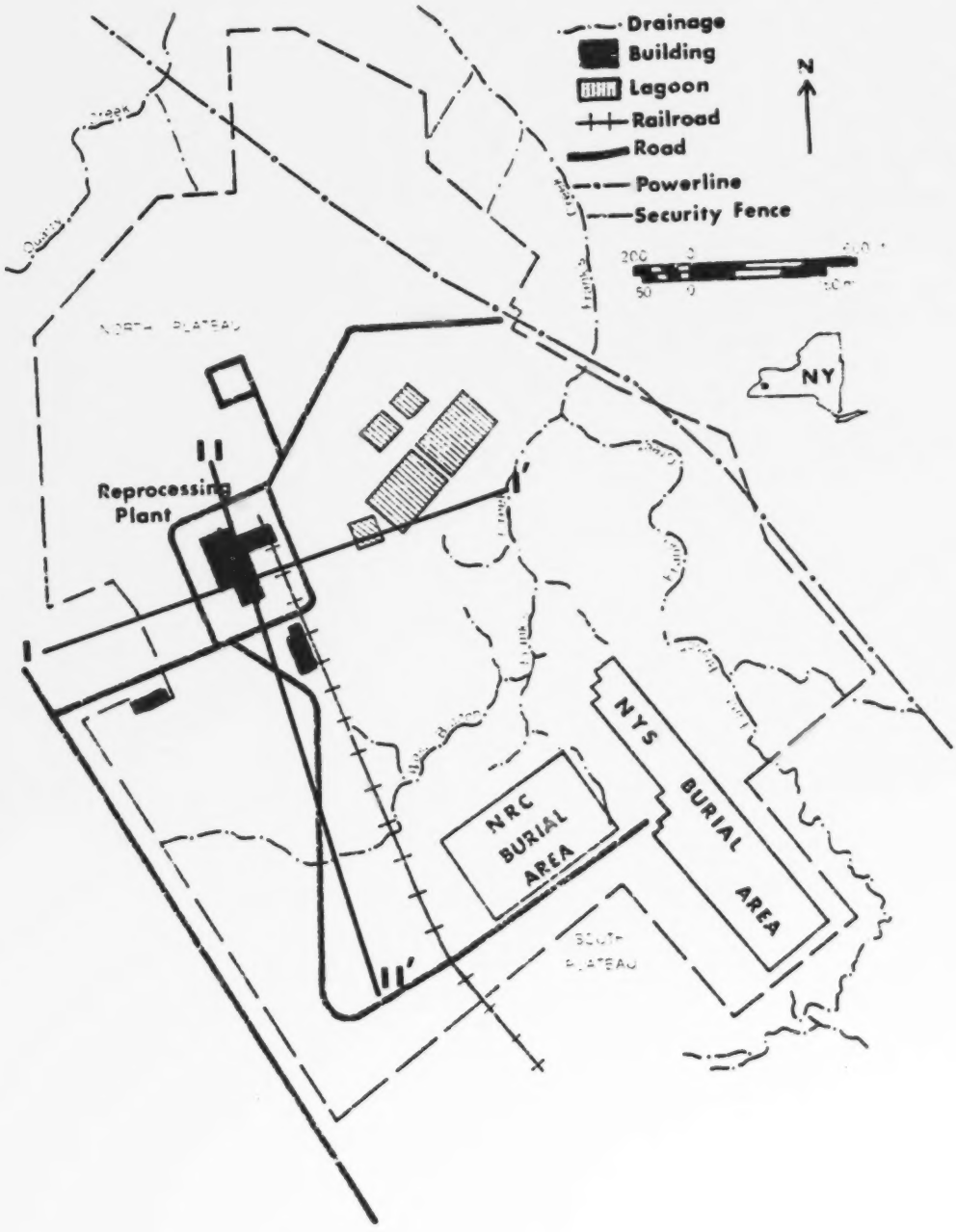


Figure 7. Map of a portion of the Western New York Nuclear Service Center showing the locations of wells drilled during the 1980 Drilling Program.

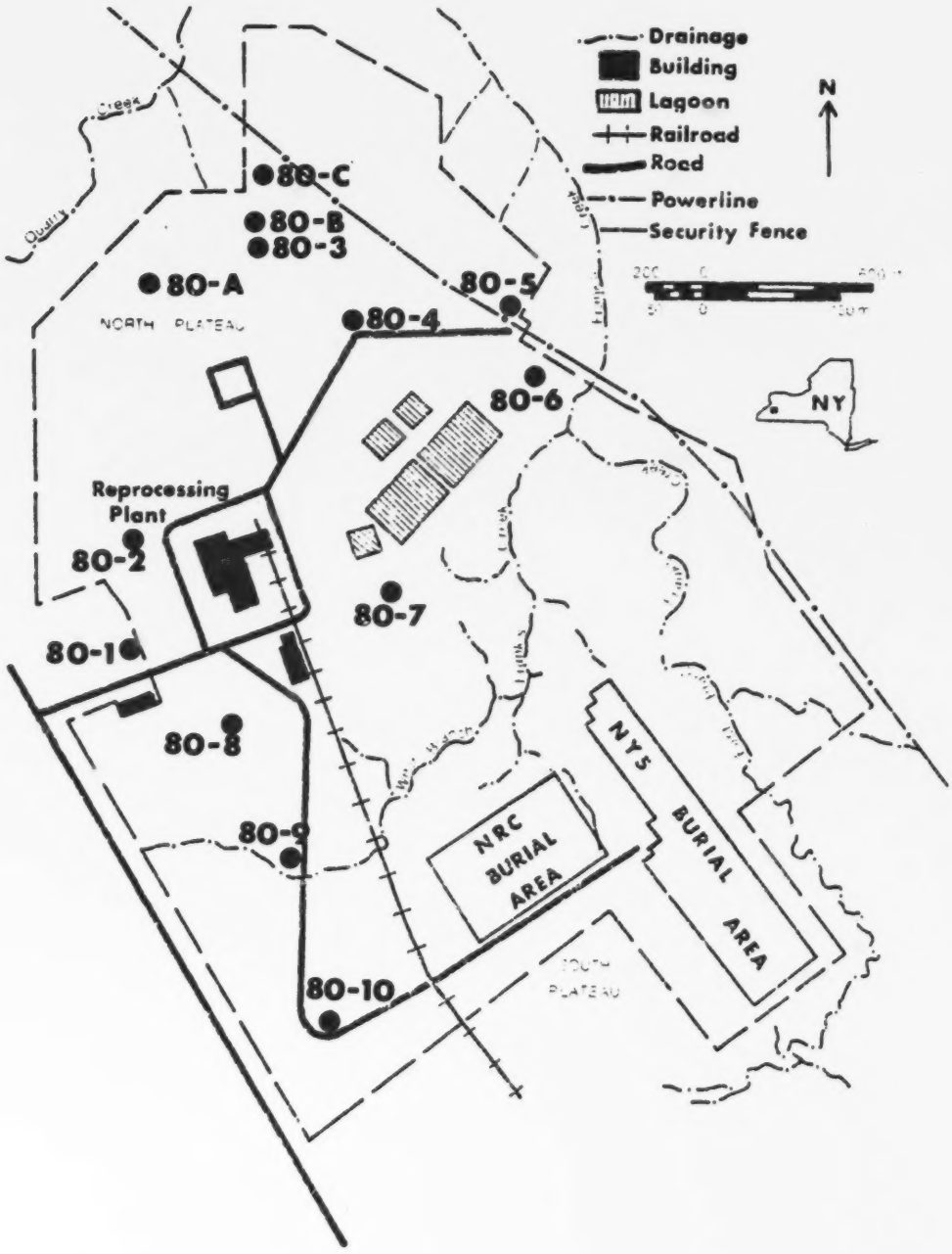


TABLE 1. Summary of the 1980 Drilling Program

Well	Total Depth Drilled (m)	Estimated Gravel Thickness (m)	Depth to Water at Well Installation (m)
80-1	7.92	0.70	4.21
80-2	4.88	4.42	3.96
80-3	2.44	1.98	1.83
80-4	4.27	3.66	2.29
80-5	4.88	4.27	1.77
80-6	5.49	5.27	Dry
80-7	2.44	1.77	1.22
80-8	7.32	6.25	4.27
80-9	6.71	1.07	5.97
80-10	12.68	0.70	8.60

cally from the NYS- and NRC-licensed burial areas in that the uppermost unit is layered gravel that forms a Quaternary alluvial fan (Figure 2). This deposit is approximately 40 feet thick and tapers toward the south. The fan material is much more coarse-grained than the till which underlies it and is relatively permeable which makes it a conduit for ground water. The data from seven of the wells determined the thickness of the surficial gravel deposit of the North Plateau and the remaining three amplified the stratigraphy west of the burial areas. The geologic and hydrologic properties of this deposit, and those of similar composition nearby will be studied further during the 1981 field season.

A six-inch, O.D., 3.25 I.D. hollow stem Power-Flight auger was used by the USGS to drill these wells. A two-inch O.D. split spoon sampler was driven two feet ahead of the auger to retrieve a continuous sample core. Two-inch diameter PVC well points were installed at all locations except three, where groundwater level recorders were installed.

Well 80-10 was sealed with concrete in October 1980. Continuous water level recorders were installed during January 1980 in wells 80-2, 80-3, and 80-4. The water levels in the six remaining wells will be recorded manually by USGS personnel.

The sediment samples were examined and described in the field by both NYSGS and USGS personnel. The NYSGS logs are included in Appendix C. Following logging, each sample was wrapped in paraffin and prepared for transport to the RSL for radiochemical analysis. Pumping tests yielded samples of groundwater which also were analyzed for radionuclides. The radiochemical analysis of the sediment samples are listed in Table 2 and the ground water radiochemistry in Table 3.

TABLE 2. Radiochemical Analyses of Sediment Samples Collected During the 1980 Drilling Program

Well	Depth (m)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	HTO (pCi/g)
80-1	0-0.6	<14	23±37%	<0.20
	7.3-7.9	18±97%	10±60%	0.48±26%
80-2	0-0.6	28±66%	19±34%	0.30±94%
	4.3-4.9	26±74%	24±28%	0.28±43%
80-3	0-0.6	<16	19±39%	0.18±41%
	0.6-1.2	<16	46±21%	0.18±66%
	1.8-2.4	50±49%	39±20%	0.13±89%
80-4	0-0.6	28±66%	36±23%	0.29±46%
	1.8-2.4	23±80%	28±31%	0.50±49%
	3.7-4.3	<15	24±28%	0.94±17%
80-5	0-0.6	<15	29±32%	0.34±43%
	4.3-4.9	40±60%	26±29%	12.0 ±5%
80-6	0-0.6	24±78%	32±26%	1.1 ±14%
	3.7 4.3	30±62%	17±47%	14.0 ±4%
	4.9 5.5	<17	18±39%	15.0 ±4%
80-7	0-0.6	<14	59±17%	0.34±37%
	0.6-1.2	25±75%	20±38%	0.30±70%
	1.2-1.8	19±99%	27±21%	0.40±68%
80-8	0-0.6	<14	30±26%	0.14±81%
	4.9-5.5	23±78%	20±34%	0.41±30%
	6.1-6.7	19±89%	19±35%	0.30±87%
80-9	0-0.6	<14	21±36%	0.80±48%
	0.6-1.2	24±80%	17±47%	0.59±22%
	1.2-1.8	30±65%	26±33%	1.1 ±16%
80-10	0-0.6	23±78%	26±29%	<0.30
	0.6-1.2	<16	23±37%	1.2 ±12%
	12.2-12 7	23±84%	20±40%	0.25±49%

TABLE 2 (continued) .

Surface Samples	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	HTO (pCi/g)
80-A	<17	31±24%	0.30±82%
80-B	<12	51±18%	0.47±32%
80-C	20±99%	26±66%	0.40±63%

TABLE 3. Radiochemical Analyses of Water Samples Collected During the 1980 Drilling Program

	Dissolved (pCi/ml)				Suspended (pCi/g)	
Well	Sampling Depth (m)	Gross Alpha	Gross Beta	HTO	Gross Alpha	Gross Beta
80-1	4.5	<6	<4	210±63%	35±51%	38±25%
80-2	4.0	<3	<4	470±28%	30±66%	30±27%
80-5	1.8	<1	<7	8400±4%	32±63%	35±25%
80-7	1.2	<1	<6	350±36%	24±78%	38±23%
80-8	1.2	<6	<4	340±37%	18±96%	39±22%

8.0 GEOMORPHIC INVESTIGATIONS

The second phase of the geomorphic and erosion study of the Buttermilk Creek drainage basin (Figure 8) was completed and reported in detail by Boothroyd and others (1981). This study was a continuation of the investigations initiated in 1978 and reported in Boothroyd and others (1979). The objectives of Phase II were determination of the seasonal, annual, and long term modification of Buttermilk Creek and its tributaries adjacent to the Western New York Nuclear Service Center in order to estimate a denudation rate for the Buttermilk Creek drainage basin. Remeasurement of parameters investigated in Phase I (Boothroyd et al., 1979) indicates geomorphic changes in Buttermilk Creek are related to bedload transport by the migration of transverse bars. Clast movement is significant (3 - 6 meters per year) in response to one-year flood events. Extreme events, such as hurricanes, result in up to 60 m of bar slip-face migration. Suspended sediment discharge during a typical yearly flood event is equivalent to the erosion of an in-place till volume of 3000 cubic meters. This is two-thirds of the estimated yearly erosion in the Buttermilk valley. Downslope slumping and earthflow of the valley wall material is thought to be a continuous process (1.5 cubic meters per year). Volumetrically, little sediment is contributed to the Buttermilk system by this process except when large masses are emplaced by block gliding.

Based on measurements of bed- and suspended-load transport and the volume of sediment deposited in the Nuclear Fuel Services water supply reservoirs, a preliminary estimate of the overall denudation rate for the Buttermilk Creek valley is 6600 cubic meters per year. The longitudinal profiles of the east and west branches of Frank's Creek indicate these tributaries are unstable and the valleys will continue to rapidly downcut and widen. Tributary erosion is independent of base-level changes in Buttermilk Creek.

A third phase of geomorphic investigation will be revision of the bar-complex map (Boothroyd et al., 1981) and measurement of clast movement at established stations to improve the data on gravel movement in the Buttermilk Creek. The terraces at several levels, identified by the previous studies, will be searched for material so that an age may be obtained in order to establish a more accurate erosional history of this drainage basin. Because floods are a major factor in the denudation of the area, a spring freshet will be monitored for water and suspended sediment discharge as

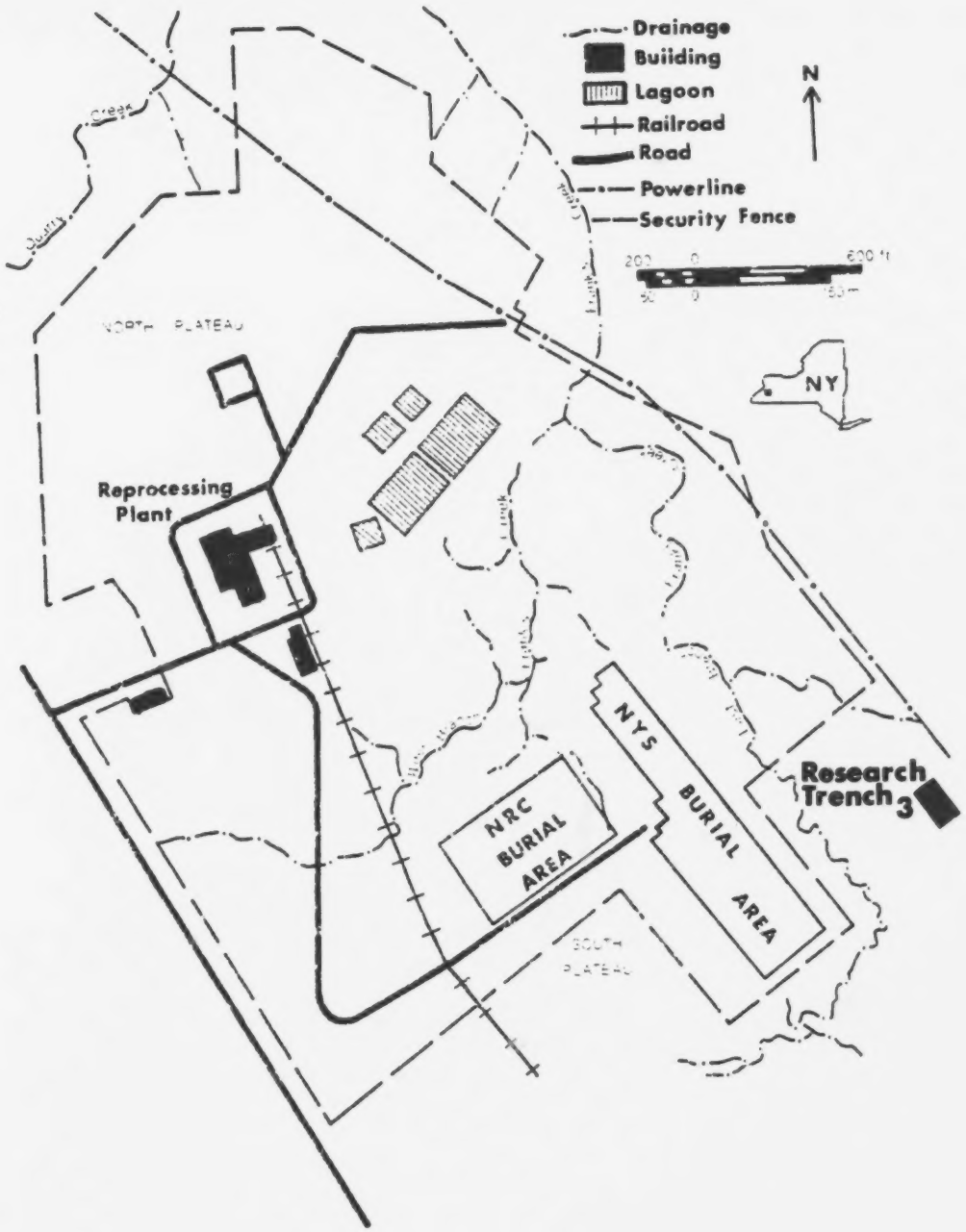
Figure 8. Map of the Western New York Nuclear Service Center illustrating the drainage basin of the Buttermilk Creek.

well as large clast movement. General mass-wasting including soil creep, slumping, earth flow, and block gliding processes will be investigated by measuring movement at, and studying the growth forms of selected trees. The identification of the geomorphic characteristics of the landslides will be generalized in an effort to identify potential instabilities.

9.0 GEOTECHNICAL INVESTIGATIONS

As part of the geologic investigation of the Western New York Nuclear Service Center site, the second part of the geotechnical analysis of soil samples was completed to evaluate the containment capability of the sediments of the NYS burial ground. Research Trench III, dug for the earlier investigation of the engineering properties of the site (Fickies et al., 1979), was left open and allowed to fill with water from rain and snow melt (Figure 9). This submersion of the sediment for almost two years was to recreate the conditions encountered by the flooding of the trenches in the NYS burial trench area. The research trench allowed direct measurement of the behavior and relative stability of the burial medium under these flooded conditions. The soil samples analyzed showed some increase in moisture content and a decrease in unit weight, indicating a slight swelling. Changes in plasticity were insignificant. The methods and results of this investigation are presented in full in Hoffman and others (1980) and confirm the predictions of engineering properties made during the first part of the geotechnical investigation (Fickies, et al., 1979).

Figure 9. Map of a portion of the Western New York Nuclear Service Center showing the location of the research trench examined during the geotechnical investigation.



10.0 SURFACE WATER INVESTIGATION

The expansion of the investigation to include the entire Western New York Nuclear Service Center site required that a more comprehensive surface water monitoring and sampling project be designed. The goal of the water studies is to describe the overall water balance more accurately and to provide a method of predicting possible radionuclide migration.

As in previous projects the surface water program was designed and is being conducted jointly by the NYSGS, the USGS, and the RSL. The USGS is responsible for the purchase, installation and maintanence of the monitoring equipment and interprets the geohydrologic records. The RSL, under subcontract with NYSGS, analyses the water and sediment samples taken at the stream stations and provides interpretations of the radiochemical results. The NYSGS has the responsibility for the development of the sampling procedure and the interpretation of the resultant surface water data.

Runoff from the site is measured by a network of stream monitoring stations. The initial stream monitoring stations were installed as part of the early USEPA-funded NYSGS research at the WNYNSC during December of 1975. The Lagoon Road and Swamp stations, previously referred to as Station Numbers Two and Four respectively, monitor the drainage from approximately half of the NYS burial trench area. The drainage for the Lagoon Road station includes a large part of the NRC burial area as well. The Frank's Creek Station, Station Nymber One, collects runoff from the largest area of the three including the remainder of the NYS burial and Southern Plateau areas. The drainage basins of each of these stream stations is shown in Figure 10.

To augment this existing network and expand the monitoring effort to the North Plateau, three new stream stations were designed and installed, with the assistance of the USGS, during the Fall of 1980. Two of the new stations, NP1 and NP3, are located on small streams draining the North Plateau area. The third permanent stream monitoring station, Burial 1, recieves drainage from the NRC burial area and part of the NYS burial trenches. The drainage basins of each of these new stations is illustrated in Figure 11.

The expanded network of stream monitoring stations now has the capability of measuring discharge, stage, and taking samples automatically for radionuclide and sediment concentration analysis for most of the water leaving the secure

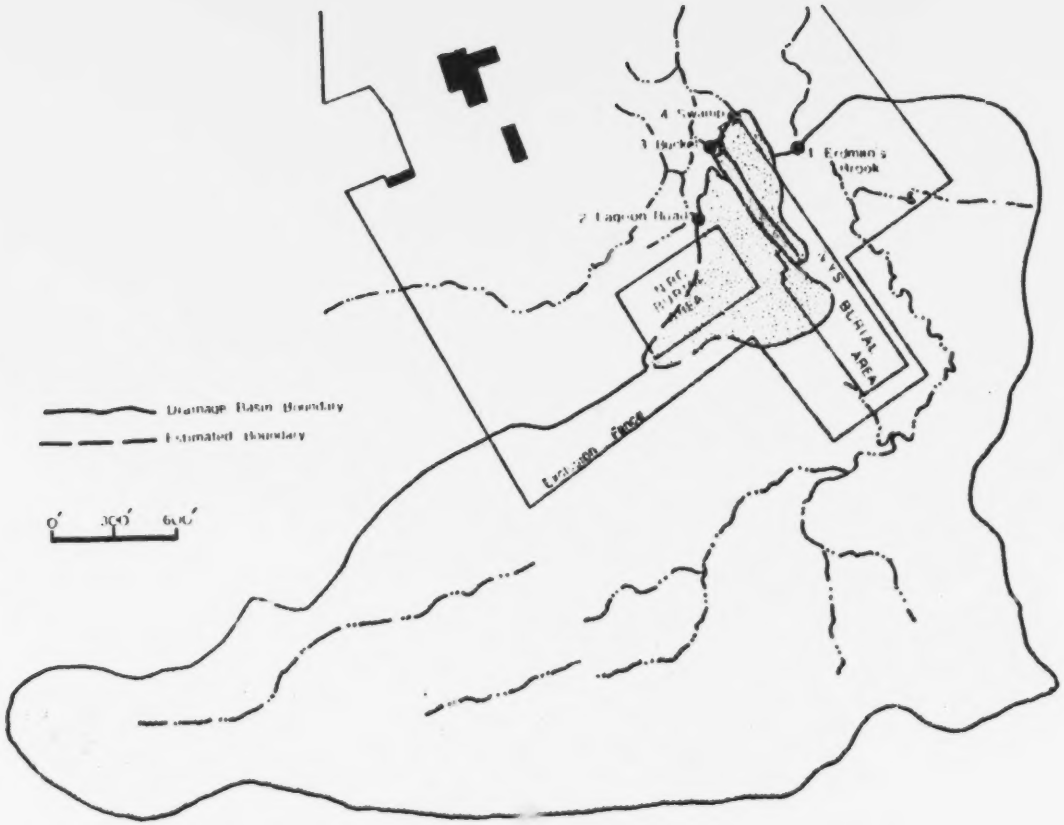
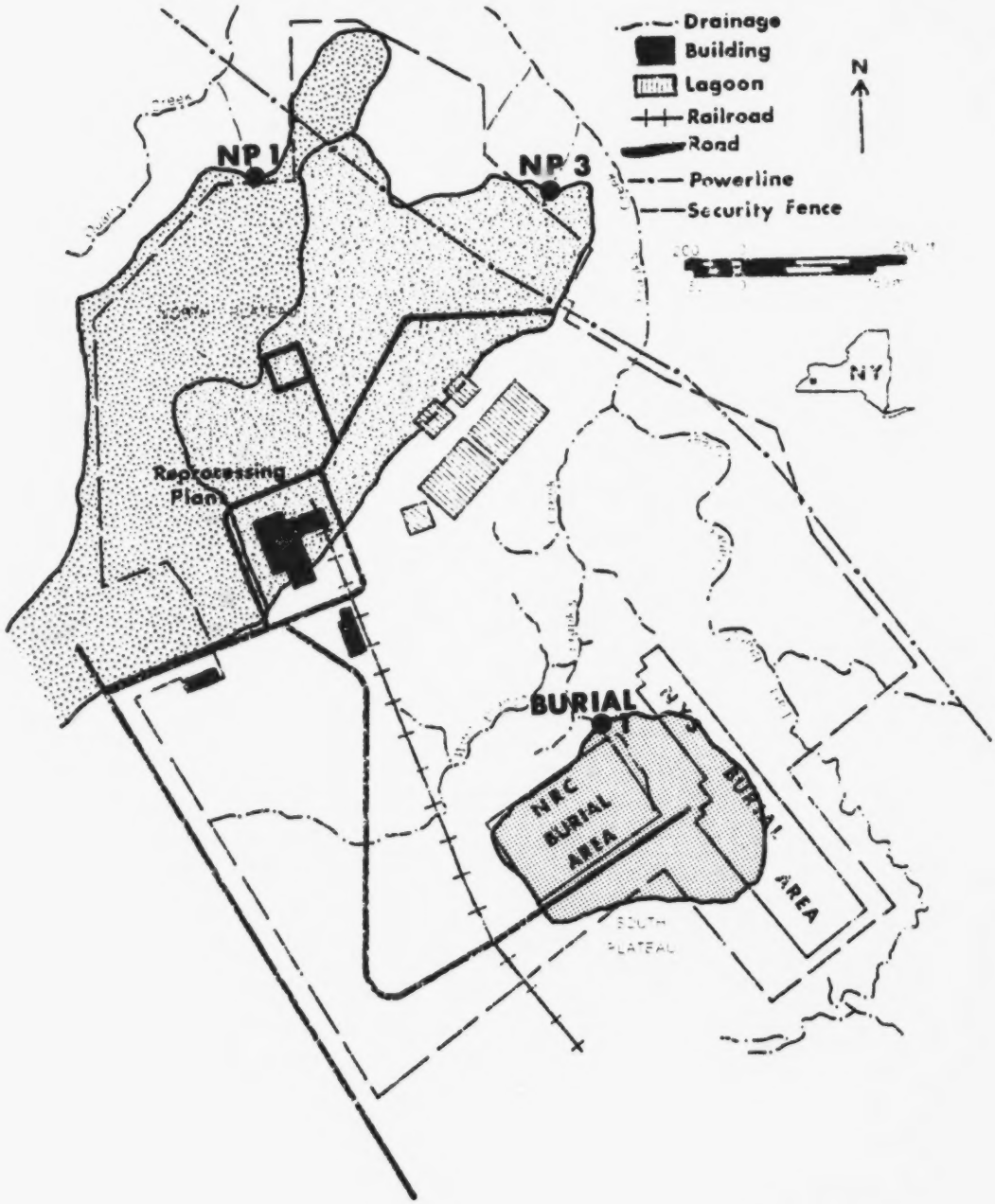


Figure 10. Map of a portion of the Western New York Nuclear Service Center showing the drainage basins monitored by the Lagoon Road, Swamp, and Frank's Creek stream stations.

Figure 11. Map of a portion of the Western New York Nuclear Service Center showing the drainage basins monitored by stream stations NP1, NP3, and Burial 1.



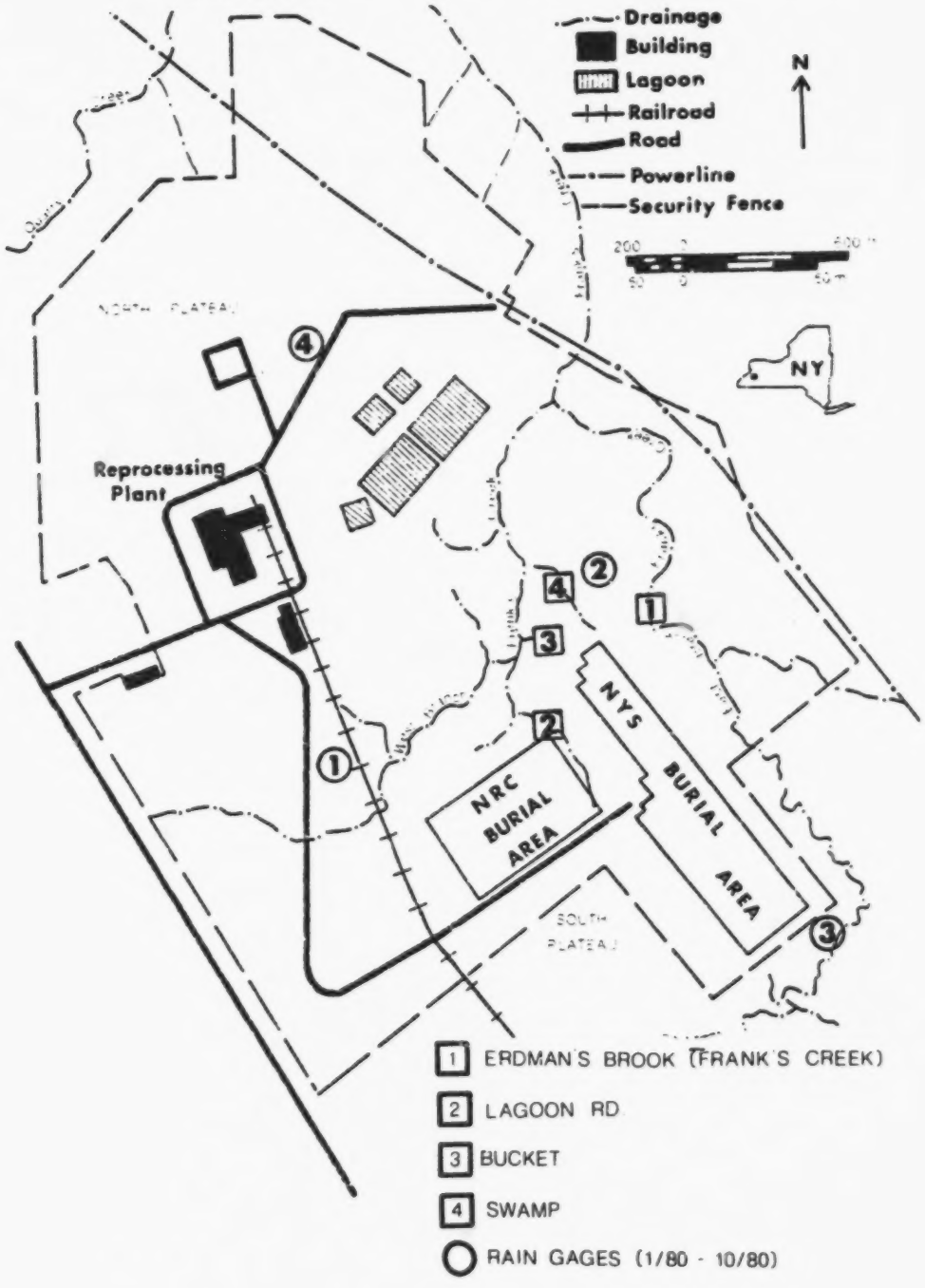
area of the WNYSC site. To aid in the definition of the water balance of the West Valley site, raingages have been maintained and a snow survey is planned to measure the total precipitation. The rainfall measured during the 1980 season is listed in Tables 4 and 5. The locations of the raingages and the stream stations are illustrated in Figure 12.

Water samples collected at the Frank's Creek, Lagoon Road, and Swamp stations have been analyzed by RSL for Gross Alpha, Gross Beta, HTO, and suspended sediment concentration. These measurements are listed in Appendixes D and E. Background radionuclide concentration analyses of water samples taken from Buttermilk Creek on May 28, 1980 are included in Table 6.

The new stream monitoring stations were designed and emplaced in an attempt to alleviate some problems that had occurred with the older stations. These older stations have never collected winter and early spring flow information because of ice and snow blockage of the monitoring channel. The new station, developed by the USGS (Figure 13) was designed to keep a section of channel open throughout the year to permit data collection. Each station is built on a steel I-beam frame assembled offsite. After the sites had been chosen and station installation procedures began, it was discovered that one of the original locations was unsuitable because of large-scale landsliding. The instability of the valley walls required footings to be dug before the station bases could be installed. As the result of this delay, the helicopter lift of the station platforms did not occur until July 23, 1980. The installation of the instrumentation, various electronic and hydraulic devices, and heating equipment did not occur until August 22, 1980, because the remote location of the station sites severely limited access; only an All-Terrain Vehicle could be used to transport equipment.

The instruments installed in the stream monitoring stations to measure stream discharge and stage include an automatic sampler to take either flow- or time-dependent water samples for radionuclide and suspended sediment analysis. A Manning F 3000A flowmeter, a Stevens Type A Model 71 stage recorder and a Manning OM-1 Overflow Monitoring Sampler were provided by the USGS to collect these data. The flow meter is the basis of this system because its electronic water sensor also activates the stage recorder and operates the flow proportioned sampler. This integrated system was supposed to collect water samples, stage and discharge measurements on

Figure 12. Map of a portion of the Western New York Nuclear Service Center showing the locations of rain gages and stream monitoring stations.



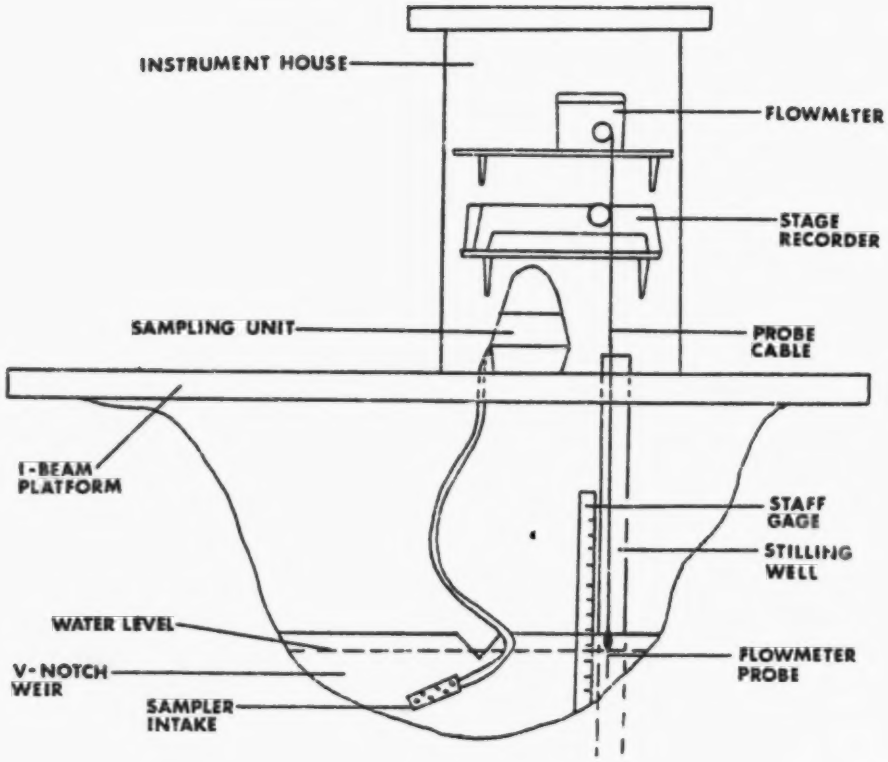


Figure 13. Diagramatic representation of the stream stations installed during 1980.

TABLE 4. Precipitation at Raingage #1, WNYNSC, West Valley, New York from 12/31/79 through 11/10/80

Week of	Gross Precipitation (inches)	Evaporation (inches)	Net Precipitation (inches)
12/31/79 - 1/7/80	0.1	0.0	0.1
1/7/80 - 1/14	No Data	No Data	No Data
1/14 - 1/21	0.025	0.0	0.025
1/21 - 1/28	0.3	0.0	0.3
1/28 - 2/4	0.25	0.0	0.25
2/4 - 2/11	0.0	0.0	0.0
2/11 - 2/14	0.08	0.02	0.1
2/14 - 2/19	0.325	0.0	0.325
2/19 - 2/25	0.35	0.0	0.35
2/25 - 3/3	0.075	0.0	0.075
3/3 - 3/10	0.95	0.025	0.975
3/10 - 3/17	0.65	0.0	0.65
3/17 - 3/24	1.25	0.05	1.30
3/24 - 3/31	0.85	0.075	0.925
3/31 - 4/7	No Data	No Data	No Data
4/7 - 4/14	0.45	0.0	0.45
4/14 - 4/21	0.3	0.05	0.35
4/21 - 4/30	0.15	0.0	0.15
4/30 - 5/5	0.4	0.15	0.55
5/5 - 5/12	0.075	0.0	0.075
5/12 - 5/19	0.95	0.1	1.05
5/19 - 5/23	0.1	0.1	0.2
5/23 - 5/30	0.0	0.0	0.0
5/30 - 6/2	0.3	0.05	0.35
6/2 - 6/9	0.5	0.1	0.6
6/9 - 6/16	0.95	0.1	1.05
6/16 - 6/23	1.95	0.1	2.05
6/23 - 6/30	0.6	0.05	0.65
6/30 - 7/7	0.75	0.05	0.8
7/7 - 7/14	0.0	0.0	0.0
7/14 - 7/21	0.0	0.075	0.075
7/21 - 7/28	0.65	0.060	0.71
7/28 - 8/4	3.9	0.15	4.05
8/4 - 8/11	1.875	0.125	2.0
8/11 - 8/18	.35	0.1	0.45
8/18 - 8/25	0.0	0.0	0.0
8/25 - 9/1	1.7	0.0	1.7
9/1 - 9/8	0.3	0.1	0.4
9/8 - 9/15	1.05	0.1	1.15

TABLE 4 (continued)

Week of	Gross Precipitation (inches)	Evaporation (inches)	Net Precipitation (inches)
9/15 - 9/22	0.2	0.05	0.05
9/22 - 9/29	0.675	0.075	0.75
9/29 - 10/5	0.65	0.025	0.675
10/6 - 10/12	1.45	0.05	1.5
10/14 - 10/21	1.00	0.05	1.05
10/21 - 10/28	3.225	0.0	3.225
10/28 - 11/3	0.075	0.0	0.075
11/4 - 11/10	1.45	0.0	1.45

TABLE 5. Precipitation at Raingage #2, WNYNSC, West Valley, New York from 12/31/79 through 11/10/80

Week of	Gross Precipitation (inches)	Evaporation (inches)	Net Precipitation (inches)
12/31/79-1/7/80	0.05	0.05	0.1
1/7 - 1/14	No Data	No Data	No Data
1/14 - 1/21	0.0	0.05	0.05
1/21 - 1/28	0.45	0.0	0.45
1/28 - 2/4	0.3	0.0	0.3
2/4 - 2/11	No Data	No Data	No Data
2/12 - 2/14	0.05	0.0	0.05
2/14 - 2/18	0.45	0.05	0.5
2/19 - 2/25	0.35	0.0	0.35
2/25 - 3/3	0.1	0.0	0.1
3/3 - 3/10	0.95	0.075	1.025
3/10 - 3/17	0.75	0.075	0.825
3/17 - 3/24	1.8	0.125	1.925
3/24 - 3/31	0.925	0.075	1.0
3/31 - 4/7	No Data	No Data	No Data
4/7 - 4/14	0.5	0.0	0.5
4/14 - 4/21	0.35	0.1	0.45
4/21 - 4/28	0.15	0.0	0.15
4/28 - 5/5	0.3	0.25	0.55
5/5 - 5/12	0.1	0.0	0.1
5/12 - 5/19	1.0	0.125	1.125
5/19 - 5/23	0.15	0.05	0.2
5/23 - 5/30	0.0	0.0	0.0
5/30 - 6/2	0.3	0.025	0.325
6/2 - 6/9	0.55	0.075	0.625
6/9 - 6/16	1.075	0.15	1.225
6/16 - 6/23	2.05	0.15	2.20
6/23 - 6/30	0.8	0.05	0.85
6/30 - 7/7	0.825	0.1	0.925
7/7 - 7/14	0.0	0.05	0.05
7/14 - 7/21	0.05	0.05	0.1
7/21 - 7/28	0.65	0.20	0.85
7/28 - 8/4	4.0	0.1	4.1
8/4 - 8/11	1.975	0.025	2.0
8/11 - 8/18	0.25	0.1	0.35
8/18 - 8/25	0.0	0.0	0.0
8/25 - 9/1	1.725	0.05	1.775
9/2 - 9/8	0.3	0.15	0.45
9/8 - 9/15	1.1	0.15	1.25
9/15 - 9/22	0.2	0.05	0.25
9/22 - 9/29	0.75	0.05	0.8

TABLE 5 (continued) .

Week of	Gross Precipitation (inches)	Evaporation (inches)	Net Precipitation (inches)
9/29 - 10/6	0.70	0.075	0.775
10/6 - 10/12	1.40	0.05	1.45
10/14 - 10/21*	1.025	0.0	1.025
10/21 - 10/28	3.50	0.05	3.55
10/28 - 11/3	0.075	0.025	0.1
11/4 - 11/10	1.50	0.05	1.55

*Estimated, raingage stopped.

TABLE 6. Background Radiochemical Analyses of Water Samples Collected from Buttermilk Creek, May 5, 1980

Dissolved (pCi/l)			Suspended (pCi/g)	
Gross Alpha	Gross Beta	HTO	Gross Alpha	Gross Beta
<2	<5	<120	<8	<17

a 24 hour, seven day basis to provide a continuous record of surface water characteristics. After the instruments were installed in the stations, calibration was required. The Manning OM-1 Overflow Monitoring Sampler takes flow proportioned samples through the use of a cam, shaped to reflect the channel geometry which relates stage to discharge. This cam is to be machined by the sampler manufacturer on the basis of a survey of the channel from which the device samples. As preliminary operation of these stations commenced on October 7, these cams had not yet been delivered and were never in place through December 3, 1980, the period the stations were maintained by NYSGS personnel. As a result the data collected during this period cannot be integrated into the Surface Water Monitoring Program which is outlined in Table 7.

TABLE 7. Surface Water Monitoring and Sampling Program Outline

Discharge Measurement

Location	Normal Frequency	Method
NP1, NP2, NP3	daily	Pygmymeter, or volume rate of flow from V notch weir with stop watch and graduated cylinder.
North Plateau (general overland flow)	when appropriate	Pygmymeter, or volume rate of flow from V notch weir with stop watch and graduated cylinder.
Frank's Creek	bi-weekly	Wading, current meter.
Burial Island	daily	Current meter or volume rate of flow.
Buttermilk Creek at Thomas Corners Road Bridge	weekly	Pygmy or AA meter, wading.

Surface Water Grab Sampling

Sample Type	Location	Normal Frequency
21 grab	NP1, NP2, NP3, Burial Island	Daily in conjunction with discharge and suspended sediment sample.
fine sediment (cloth bag)	NP1, NP2, NP3, Burial Island	monthly

TABLE 7 (continued) .

Storm Event Routine

Location	Method
NP1, NP2, NP3, Burial Island, Thomas Corners Road	1. Multiple Q measurements, by various means to quantify the stage record. 2. Collect incremental surface H_2O grab samples as stage changes. 3. Collect multiple manual suspended sediment samples to supplement samples collected automatically. 4. Constant monitoring of automatic equipment to assure quality of data collected.

11.0 SUMMARY

The NYSGS study of the entire WNYNSC site is an outgrowth and expansion of the interdisciplinary research project which included geologic, geomorphic, geotechnical, and hydrologic investigations of the NYS-licensed burial trench area between 1975 and 1980. This is the first progress report of the expanded program, which has a proposed schedule of several years duration. For background, a general history, including Paleozoic, Pleistocene, and Holocene events, is included in this report.

A topographic map of the area occupied by the nuclear fuel reprocessing plant and the burial areas for radioactive waste has been produced on a large enough scale (1:100) to serve as a base map for these investigations. Ten wells were drilled in the North Plateau to install a groundwater monitoring system and to define the geometry of the surficial gravel deposit found in this area. Preliminary stratigraphy, presented in the north-south and east-west geologic cross sections, resulted from this drilling project.

The geomorphic study of the Buttermilk Creek Drainage basin, continued from previous NYSGS investigation, recently compelted its second phase. This includes estimates of an overall denudation rate through the measurement of bed-load movement, suspended sediment discharge, and the rate of mass wasting in the creek valley walls.

The sediments within a research trench, dug for an earlier investigation and permitted to stand full of water for two years, were reexamined to determine what changes in their geotechnical properties long term submergence produced. No major variations in the characteristics of the burial till occurred.

The surface water program, originally designed to monitor the runoff from only the NYS burial area, was expanded to include the North Plateau with the addition of new permanent stream stations. The new stations have the potential capability of measuring discharge, stage and taking samples automatically on a flow proportional basis to allow for more complete monitoring of the radionuclide and suspended sediment concentrations in the runoff from the site. To date, these stations have not operated to their full potential.

The interpretation of the data collected during this part of the study has allowed for the delineation of new areas

that need investigation to complete this research project. These areas include deep drilling to obtain information on the composition of strata underlying the entire area, the continuation of the geomorphic study of Buttermilk Creek's drainage basin, sedimentology and petrology of the principal glacial strata, a study of the erosional history of the Cattaraugus Creek, and additional surface water monitoring capabilities to more accurately measure the effect of storm events. This combination of new projects and the expansion of existing ones will result in a more thorough knowledge of the geologic and hydrologic characteristics and processes occurring at the WNYNSC site.

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APPENDIX A

REPORTS OF STUDIES BY THE NEW YORK STATE GEOLOGICAL SURVEY AT THE WESTERN NEW YORK NUCLEAR SERVICES CENTER

(1) Bailey, H. H. (in press). Research at the West Valley, New York, Low-Level Radioactive Waste Burial Site. In a draft report of Other Shallow Land Burial Sites, sponsored by the United States Nuclear Regulatory Commission, April 22 and 23, 1980.

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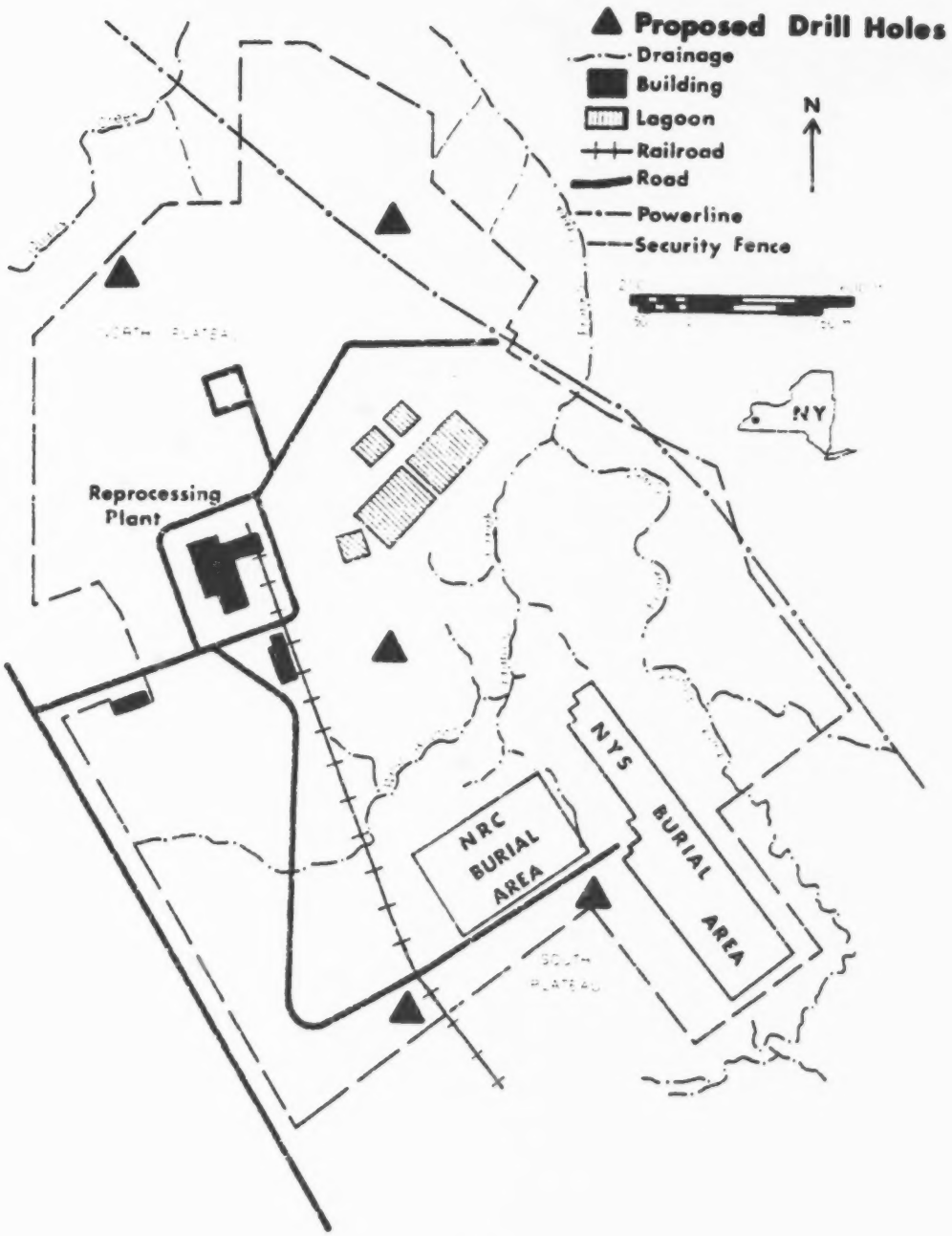
APPENDIX B

PROPOSED DEEP DRILLING PROGRAM

Deep Drilling Program

As part of the cooperative research program, the New York State Geological Survey and the United States Geological Survey have proposed to drill five deep holes at the Western New York Nuclear Services Center. These holes will be cored and the core samples fully described to establish the stratigraphy of the entire thickness of glacial deposits in the pre-glacial Buttermilk Creek Valley. The extent of hydraulic conductivity and distribution of head of the groundwater in these deeper glacial deposits will also be measured. Tentative locations for these deep holes are illustrated in Figure 14. The final locations of all holes will be mutually agreed upon between the surveys and approved by the New York State Department of Environmental Conservation, site regulator, the New York State Energy Research and Development Authority, site owner, the operator of the site and the U. S. Nuclear Regulatory Commission.

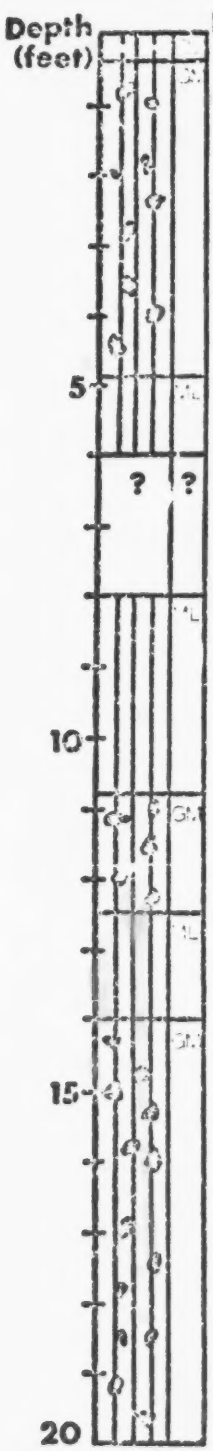
Figure 14. Map of a portion of the Western New York Nuclear Service Center showing the tentative locations of the proposed deep drilling.



APPENDIX C

GEOLOGIC LOGS OF WELLS DRILLED DURING THE 1980 DRILLING PROGRAM

Figure 15.
GEOLOGICAL LOG OF CORE 80 - 1



Damp organic silt; little clay; trace sand.

Olive-brown angular gravel; little silt; trace sand; trace shale, siltstone, and fine sandstone cobbles.

(Grading to dark gray)

Gray-brown, soft, nearly saturated silt; some sand; little gravel or cobbles; trace clay.

No sample
Perched water table at 7 ft.

Gray-brown, non-saturated silt; some gravel; trace sand; trace clay.

Gray-brown coarse gravel and silt; little sand; trace clay.

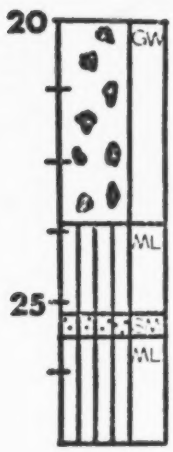
Gray-brown silt and gravel; trace sand; trace clay

Gray-brown saturated coarse gravel and silt; trace sand; trace clay; grading to gravel with some silt; trace clay; trace sand.
Grading to light olive gray.
Grading from subangular to subrounded cobbles.

(Cohesionless, saturated, with pore space-good porosity)

(Tight, impervious, slightly plastic)

CONTINUATION OF GEOLOGICAL LOG OF CORE 80 - 1



Olive-gray, fine gravel and coarse sand; trace silt. Good permeability.

Olive-gray, stiff, tight silt; some clay; trace fine gravel.

Olive-gray sand; some silt.

Olive-gray silt; some clay; little gravel; trace cobbles.

Hole completed at 26 ft.
Groundwater at 13.75 ft.
Vertical scale 1:30

TABLE 8
Geologic Log of Core 80-1
September 23, 1980
Surface Elevation 1422 Feet

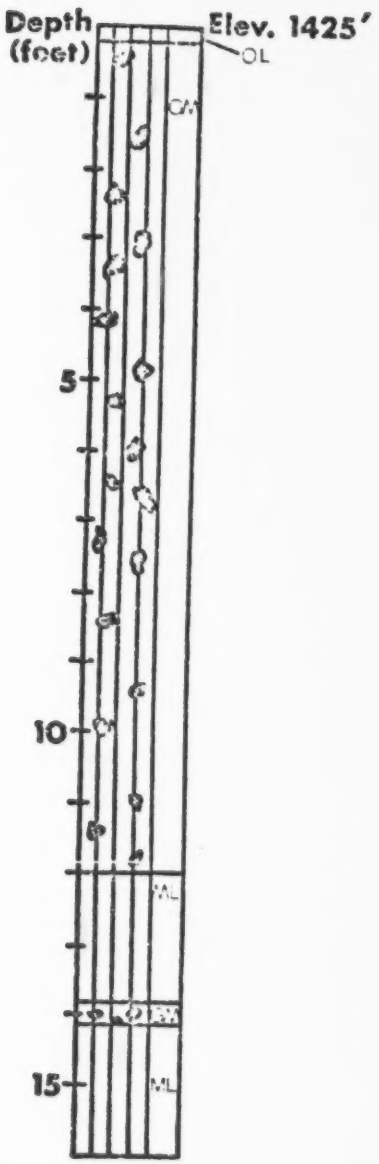
Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-4	14	4" damp organic SILT, little clay, trace sand. 10" olive-brown, angular GRAVEL, little silt, trace sand, trace cobbles of shale and siltstone, also fine sandstone clasts.
2-4	13	7" (mottled yellow) gray-brown coarse, angular GRAVEL, some silt, trace clay, trace sand. 6" dark gray GRAVEL as above.
4-6	18	10" GRAVEL as above, with two large clasts at very top of core 8" soft, near-saturated gray-brown SILT, some sand, little gravel and cobbles, trace clay.
6-8	0	No sample. Plate driven in front of sampler for full 24". Perched water table at 7 feet.
8-10	15	Fractured quartz cobble at top. 13" non-saturated gray-brown SILT some gravel, trace sand, trace clay. Iron oxides (goethite) common.
10-12	19	8" gray-brown SILT with some clay. Gray-brown coarse GRAVEL and SILT, little sand, trace clay. Low cohesion, non-saturated.
12-14	16	6" GRAVEL and SILT as above with quartzite pebbles. 10" gray-brown SILT and GRAVEL, trace sand, trace clay. Water at 13' 9".

TABLE 8 (continued) .

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
14-16	19	Saturated gray-brown coarse GRAVEL and SILT, trace sand, trace clay, grading to GRAVEL with some silt, trace clay, trace sand.
16-18	14	Saturated, light olive-gray GRAVEL with some silt, little angular, sub-rounded 3" cobbles. GRAVEL and SILT. Clasts light olive-gray silty shale with oxidized red-brown horizons parallel to bedding, some fossils.
18-20	18	Cohesionless, saturated light olive-green, coarse GRAVEL with little silt, pore space present. Bottom 6" tight GRAVEL, some silt, little clay. Impervious, slightly plastic.
20-22	12	Fine GRAVEL and coarse SAND, trace silt. Gravel and sand primarily fine-grained tough quartzite. Good permeability.
22-24	19	10" as above 9" stiff, olive-gray, tight, SILT some clay, trace fine gravel. TILL at 22' 11".
24-26	23	2" as above 4" SAND with some silt 17" olive-gray SILT, some clay, little gravel, trace cobbles.

Bottom of hole at 26 feet
Cuttings 26" - 23'
2" I.D. PVC 6 - slot screen 23' - 13'
2" I.D. PVC pipe 13' - 30"
Sand poured around screen to 9.5'
Bentonite/sand (3/1) mixture to seal around casing 9.5'-4'

Figure 16.
GEOLOGICAL LOG OF CORE 80 - 2



Moist silt (topsoil).

Olive-brown loose, slightly damp gravel; some silt;trace of sand and trace of clay.

(Grading, medium dense)

(Tignt, grading, occasional cobble)

Olive-brown unsaturated silt; some gravel; trace of clay.

Olive-brown saturated, oxidized gravel and silt.

Olive-brown, very stiff, saturated silt; some clay.

Hole completed at 16 ft.
Groundwater at 6.8 ft.
Vertical scale 1:30

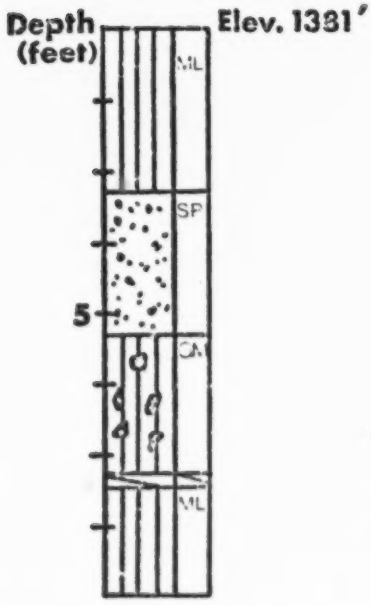
TABLE 9
Geologic Log of Core 80-2
September 24, 1980
Surface Elevation 1425 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	18	2" moist topsoil 16" loose, slightly damp olive-brown GRAVEL, some silt, trace sand, trace clay. Sandstone, siltstone, quartzite clasts.
2-4	15	Medium dense, slightly damp, olive brown GRAVEL, some silt, trace sand, trace clay.
4-6	14	5" GRAVEL, some silt, trace clay, occasional cobble. 9" fine to coarse GRAVEL, some silt, some clay, tighter than top 5". Gravel is fine with patches of coarse.
6-8	0	Sample mostly pulvesized, probably same as above.
8-10	--	Damp, olive-brown, fine GRAVEL and SILT, little coarse gravel, trace clay. No shale fragment gravel found to 8'.
10-12	14	Dense, moist, olive-brown, fine GRAVEL and SILT, trace clay. Clay content slightly higher than above.
12-14	12	Unsaturated, SILT with some gravel, trace clay. Grading more clay than above. Water at 12' 11". Bottom 2" saturated, oxidized, olive-brown, GRAVEL and SILT.
14-16	16	2" GRAVEL and SILT as above. 14" very stiff, saturated, oxidized, olive-brown SILT, some clay.

TABLE 9 (continued) .

Bottom of hole at 16'.
Hole caved in 16' - 14'.
2 3/8" I.D., G-slot galvinized screen 14'-9'.
2" I.D. galvinized pipe 9'-11" above surface.
Cuttings 14' - 8' 3".
Bentonite/sand mixture 8' 3" - 4' 6".
Cuttings 4' 6" - surface.
6' section of 3" I.D. galvinized pipe driven 5' into ground around the 2" casing to seat water level recorder housing.
Dry bentonite tamped between two pipes.

Figure 17.
GEOLOGICAL LOG OF CORE 80 - 3



Red-brown silt; little gravel; trace clay.

Olive-brown loose, dry to damp sand and gravel; trace silt; trace clay.
(Good permeability)

Olive-brown coarse gravel and sand; little silt; trace clay.

Gradational

Olive-brown silt; some clay; trace fine gravel.

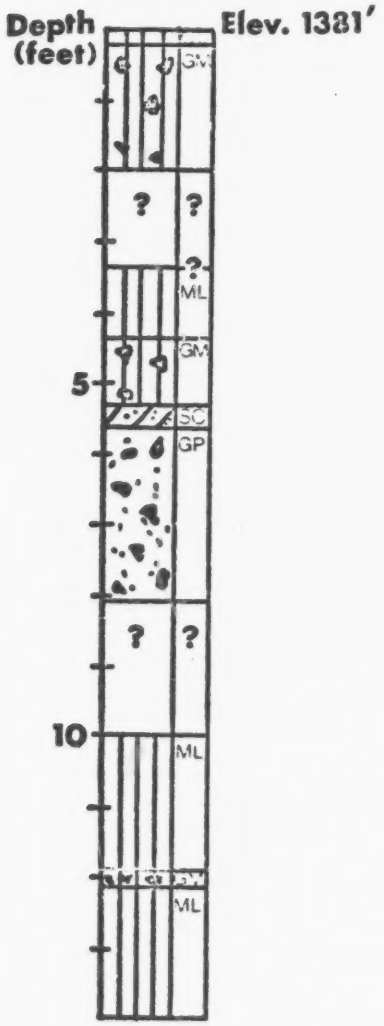
Hole completed at 8 ft.
Groundwater at 5.7 ft.
Vertical scale 1:30

TABLE 10
Geologic Log of Core 80-3
September 24, 1980
Surface Elevation 1381 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	20	Red-brown SILT, little gravel, trace clay. No topsoil.
2-4	17	Top 3" same as above 14" loose, dry to damp, olive-brown, SAND and GRAVEL, trace silt, trace clay, good permeability
4-6	11	Top 4" same as above Olive brown, coarse GRAVEL and SAND, little silt, trace clay Water at 5' 11"
6-8	--	Top 3" weathered brown, as above. 3" graditional 12" olive brown, SILT, some clay, trace fine gravel

Bottom of hole at 8'.
Hole caved in 8' - 6'.
2" 6-slot PVC screen 6'-4'.
2" PVC casing 4' to 19" above land surface.
Sand and Bentonite 4' to land surface.

Figure 18.
GEOLOGICAL LOG OF CORE 80 - 4



Organic silt with roots.

Olive-brown gravel and silt; trace clay.

No sample collected @ 2 ft to 4 ft.

Olive-gray, soft silt, trace clay; no stone.

Olive-gray, medium to coarse gravel and silt.
Olive-gray fine sand; trace clay.
Olive-brown, loose fine gravel; little coarse sand; little silt; trace clay.

No sample.

Olive-gray silt; some clay; trace gravel.

Olive-gray gravel; some coarse sand; trace silt; trace clay.

Olive-gray silt; some clay; some gravel.

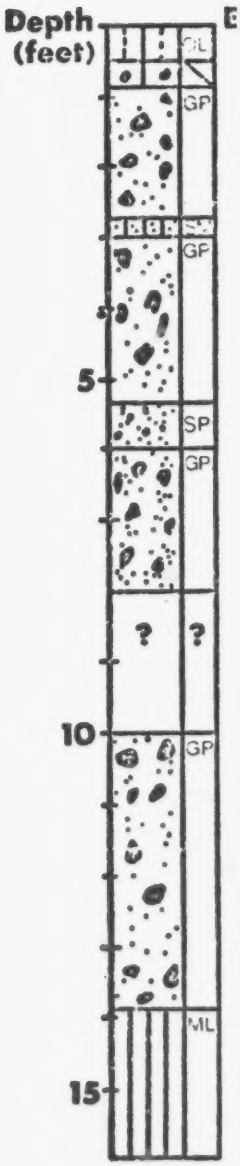
Hole completed at 14 ft.
Groundwater at 6.1 ft.
Vertical scale 1:30

TABLE 11
Geologic Log of Core 80-4
September 25, 1980
Surface Elevation 1381 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	11	Top 2" organic SILT w. roots
2-4	1	No sample collected
4-6	14	Soft olive-gray SILT, trace clay, no stones. M. - C. GRAVEL and SILT olive-gray f. SAND, trace clay.
6-8	17	Loose olive-brown f. GRAVEL, little silt, trace clay.
8-10	1	1" GRAVEL w/ little silt.
10-12	18	Olive-gray SILT, some caly, trace silt, trace clay. Olive-gray SILT, some clay, some gravel (black shale fragments)

Bottom of hole at 14'.
Bentonite pellets 14' - 10'.
2 3/8" galvinized 6-slot screen 10'-5'.
2" I.D. galvinized pipe 5' to 2' above land surface
3" I.D. galvinized pipe around 2" I.D. pipe.
3' depth to 17" above land surface
carbonate sand 10' to 4' 6"
3:1 bentonite-sand 4' 6" to land surface

Figure 19.
GEOLOGICAL LOG OF CORE 80 - 5



Black organic-rich silt; trace sand; trace clay (with roots).
Gradational

Yellow-brown fine to coarse gravel; some fine to coarse sand; little silt.

Olive-brown fine to medium sand; trace silt; trace clay.

Olive-brown fine gravel; trace to little coarse sand; trace silt.

Olive-brown, saturated fine to coarse sand; some fine gravel.

Olive-brown, fine saturated gravel; some coarse sand; trace clay; trace silt.

No sample.

Olive-gray saturated fine to medium gravel; some fine to coarse sand; little silt.

Light brown silt; some gravel; little clay. (Grading to olive-gray).

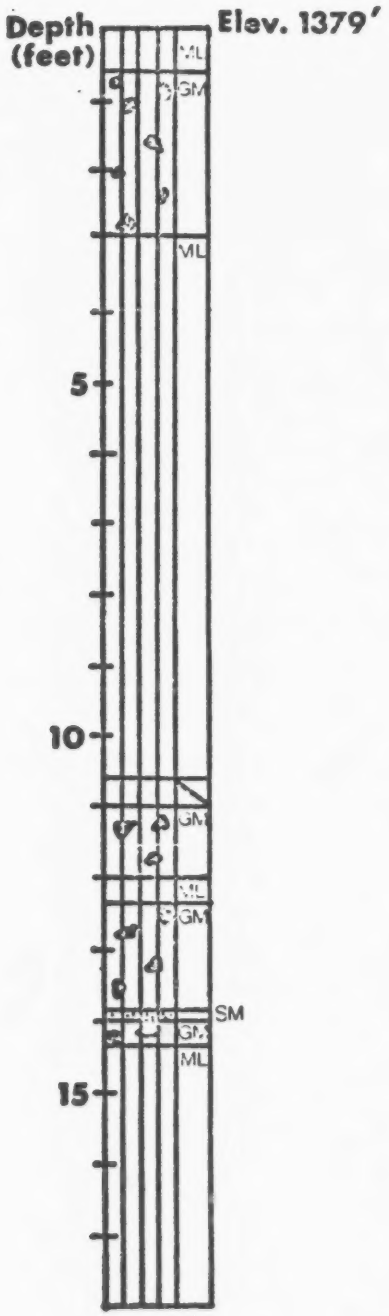
Hole completed at 16 ft.
Groundwater at 5.7 ft.
Vertical scale 1:30

TABLE 12
Geologic Log of Core 80-5
September 25, 1980
Surface Elevation 1371.8 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	16	6" black organic-rich SILT, trace sand, trace clay. (w/roots) 5" GRADATIONAL 5" yellow-brown f. to c. GRAVEL, some f. to c. sand, little silt
2-4	16	9" olive brown GRAVEL as above 3" f. to m. SAND, trace silt, trace clay. 4" olive brown f. GRAVEL, trace c. sand, trace silt.
4-6	19	16" olive-brown f. GRAVEL, little c. sand 3" olive-brown saturated f. to c. SAND, some f. gravel.
6-8	16	F. GRAVEL, some c. sand, trace clay, trace silt (saturated)
8-10	--	No sample collected
10-12	2	Saturated olive gray GRAVEL, some sand, little silt.
12-14	24	F. to m. GRAVEL, little f. to c. sand, little silt. 1" light brown SILT, some clay
14-16	17	4" SILT, some gravel, little clay 13" SILT, little clay (unweathered olive gray at 14' 11")

Bottom of boring at 16'.
Hole caved in 16' - 14'.
2 3/8" I. D. galvinized 6-slot screen 14' - 3'.
2" I.D. galvinized casing 3' to 2' 4" above land surface
Water sample 80-5-W1 collected after installation of casing.

Figure 20.
GEOLOGICAL LOG OF CORE 80 - 6



Silt; some or little clay.

Medium-gray, fine to coarse gravel; some silt; some sand.

(Grading medium dense)

Olive-brown, dense silt and clay; trace coarse gravel.

Gradational

Olive-brown, fine to very coarse gravel; some sand; little silt.
Olive-brown silt; little gravel; little sand.
Olive-brown gravel and sand; little silt; trace clay.

Olive-brown coarse sand; little silt; (good permeability).
Olive-brown, very soft, well-sorted silt; trace sand.

(Grading more clay)

(Grading to very stiff silt and clay with poor permeability)

Hole completed at 18 ft.
Groundwater not encountered.
Vertical scale 1:30

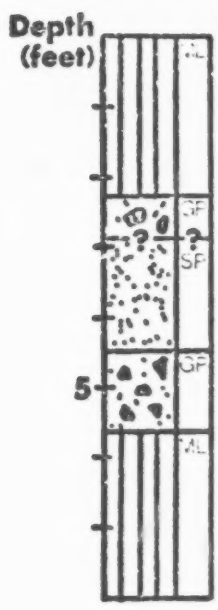
TABLE 13
Geologic Log of Core 80-6
September 26, 1980
Surface Elevation 1379

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	13	7" SILT, some or little clay Loose medium gray f. to c. GRAVEL some silt, some sand.
2-4	14	3" loose GRAVEL as above 8" medium dense weathered yellowish reddish-brown GRAVEL as above. 3" olive brown SILT and CLAY.
4-6	15	Olive brown SILT and CLAY, trace c. gravel (shale, quartzite)
6-8	6	Dense olive brown SILT and CLAY
8-10	7	Dense SILT and CLAY as above
10-12	14	11" olive-gray brown SILT and CLAY 3" olive brown f. to very c. GRAVEL, some sand, little silt
12-14	14	4" SILT, little gravel, little sand Olive-brown GRAVEL and SAND, little silt, trace clay. 2" c. SAND, little silt.
14-16	14	GRAVEL, some sand, some silt Very soft, well-sorted olive-brown SILT, trace sand. 3" SILT, some caly.
16-18	20	7" SILT as above, grading more clay. 4" SILT as above, grading more clay becoming more gray. 9" very stiff olive gray SILT and CLAY.

TABLE 13 (continued).

Bottom of hole at 18'
Bentonite pellets 18' - 14'
2" I.D. 6-slot PVC screen 14' - 12'
2" I.D. PVC pipe 12' - 36" avove land surface
Bentonite-sand mixture 12' to land surface

Figure 21.
GEOLOGICAL LOG OF CORE 80 - 7



Brown, damp silt; trace clay.

(Grading to trace medium to coarse gravel)
Brown, coarse angular gravel; some sand.

Olive-brown, saturated sand and gravel.

Olive-brown, medium to coarse gravel and sand.

Brown, stiff silt; some gravel; trace clay.

(Grading to olive-gray)

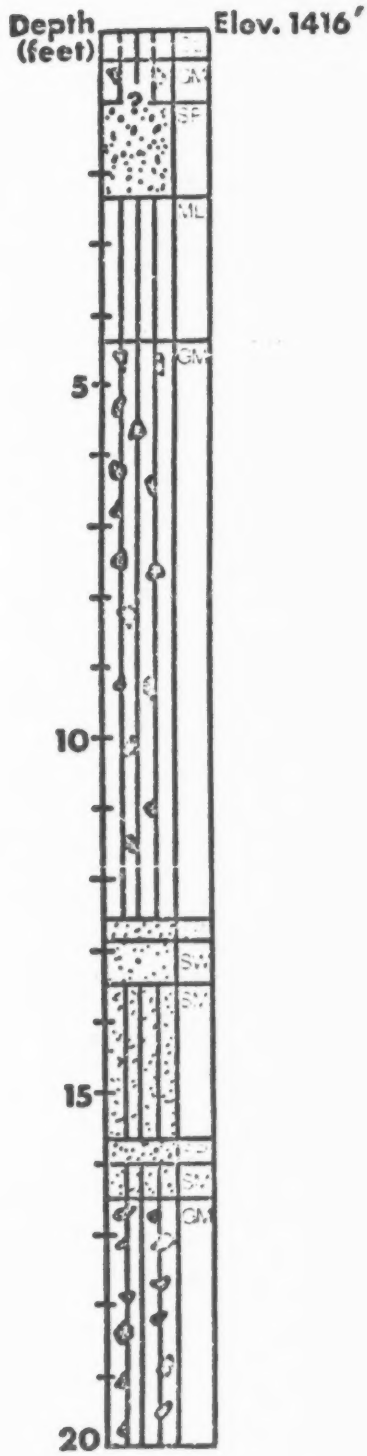
Hole completed at 8 ft.
Groundwater at 2.1 ft.
Vertical scale 1:30

TABLE 14
Geologic Log of Core 80-7
September 29, 1980
Surface Elevation 1390.5

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	19	Damp, brown SILT, trace clay Bottom 3" grading more m.-c. ang.-subang. gravel
2-4	10	3" brown SILT, some m.-c. gravel Brown c. ang. GRAVEL, some sand
4-6	22	6" saturated olive-brown SAND and GRAVEL. Grading more m.-c. gravel 2½" stiff brown SILT, some gravel
6-8	15	Stiff brown-gray SILT, trace m.-f. gravel, trace clay. (grading to olive gray)

bottom of hole at 8'.
2" I.D. 6-slot PVC screen 6' - 3'.
2" I.D. PVC pipe 3' - 28" above land surface
Sand 6' - 1'
Bentonite 1' to land surface
(Cave-in and bentonite pellets 8' - 6')

Figure 22.
GEOLOGICAL LOG OF CORE 80 - 8



Dark brown, damp organic silt and sand.

Brown, coarse, sub-angular gravel grading to cobbles.
Dark brown, damp sand; some fine to coarse subangular gravel.

Red-brown silt; some gravel; occasional cobble.

(Grading to trace fine sand)
Red-brown, moist gravel; some sand; some cobbles; trace sand.

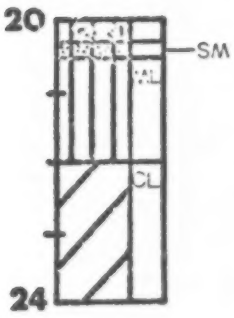
(Grading to more silt)

Brown, saturated, coarse sand; trace gravel.
Brown, saturated, medium to coarse sand.

Olive-brown, very soft, saturated silt and sand; trace fine to coarse angular gravel.

Dark brown, saturated, loose, coarse sand with some fine to coarse gravel.
Gray-brown, saturated silt and sand; trace fine gravel.
Olive-brown, fine to coarse angular gravel; trace silt; trace sand.

CONTINUATION OF GEOLOGICAL LOG OF CORE 80 - 8



Gray, medium sand; trace silt.

Gray silt; trace fine sand; occasional medium, angular gravel.

Gray clay and silt; trace fine sand. (Grading to no silt, grading to trace medium, angular gravel)

Hole completed at 24 ft.
Groundwater at 9.45 ft.
Vertical scale 1:30

TABLE 15
Geologic Log of Core 80-8
September 29, 1980
Surface Elevation 1416 Feet

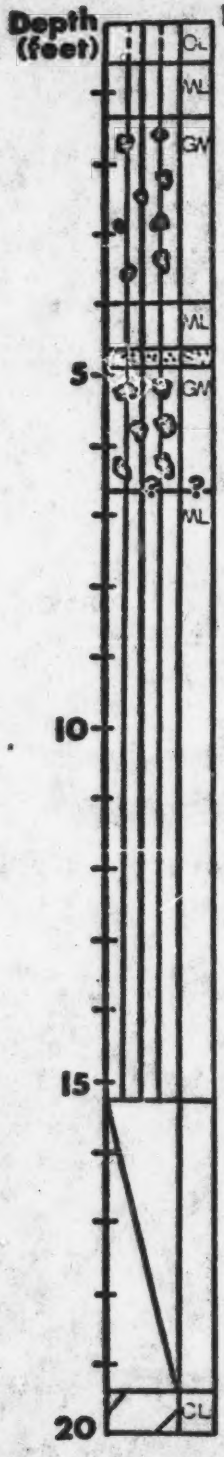
Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	12	2" damp dark brown organic SILT and SAND 10" brown c. subang. GRAVEL, grading to cobbles.
2-4	14	2" damp dark brown SAND, some f. to c. subang. gravel Red-brown SILT, some gravel, occasional cobble.
4-6	--	5" SILT as above, trace f. sand 8" moist red-brown GRAVEL, some sand, some cobbles, trace silt.
6-8	--	Slightly damp brown f. to m. GRAVEL, some sand, little silt. Grading more silt.
8-10	--	9" f. to m. GRAVEL as above. 5" c. ang. GRAVEL, trace sand, trace silt.
10-12	10	3" damp brown f. to c. GRAVEL, some silt, little sand. 7" saturated gray brown f. to c. GRAVEL, some silt, little sand.
12-14	20	7" GRAVEL as above 3" saturated c. SAND, trace m. gravel 8" saturated brown m. - c. SAND 4" soft, saturated brown SILT and SAND
14-16	23	20" very soft, saturated olive brown SILT and SAND, trace f. to c. ang. gravel 3" staurated loose dark brown c. SAND, some f. to c. gravel

TABLE 15 (continued).

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
16-18	13	6" saturated gray brown SILT and SAND, trace f. gravel 3" olive brown f. to c. ang. GRAVEL, trace silt, trace sand. 4" saturated brown c. ang. GRAVEL trace silt, trace sand.
18-20	14	4" olive brown GRAVEL as above. 7" olive medium stiff f. to c. GRAVEL and SILT, trace sand. 5" loose dark gray GRAVEL, some silt, trace m. sand.
20-22	16	3" loose gray f. to c. ang. GRAVEL, trace silt, trace sand. 3" gray m. SAND, trace silt. 8" SILT, grading less sand. 2" gray SILT, trace f. sand, occasional in. ang. gravel.
22-24	12	9" gray CLAY and SILT, trace f. sand. 3" firm gray CLAY, trace m. ang. gravel

Bottom of hole at 24'.
Bentonite pellets 24'-21'.
2" I.D. 6-slot PVC screen 21'-11'.
2" PVC pipe 11' to 33" above land surface
Cave-in material 11' - 9'.
Bentonite 9' to land surface

Figure 23.
GEOLOGICAL LOG OF CORE 80 - 9



Brown, damp silt (topsoil)

Orange-brown, damp silt; little gravel.

Orange-brown gravel; some silt; occasional cobble.

Brown-gray, stiff silt; some clay; trace medium gravel.
Gray, medium sand; trace silt.
Gray, medium to coarse gravel; little medium sand; trace silt.

Dark.gray, damp, firm silt; some medium angular gravel; trace clay.

(Grading to little clay)

(1 inch silt and very fine sand)

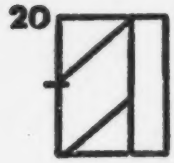
(Gravel grading out)

(Grading to more clay)

Clay and silt.

Olive-gray, damp, firm, compact clay; some silt; some medium to coarse, angular gravel.

CONTINUATION OF GEOLOGICAL LOG OF CORE 80 - 9



Hole completed at 22 ft.
Groundwater at 19.6 ft.
Vertical scale 1:30

TABLE 16
Geologic Log of Core 80-9
September 30, 1980
Surface Elevation 1389 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	21	Top 3" damp brown SILT (topsoil) 12" damp orange-brown SILT little gravel. (Top 4" organic-rich). 6" orange-brown GRAVEL, some silt, occasional cobble.
2-4	14	4" damp olive-brown f. to c. GRAVEL and SILT, trace c. sand. 7" olive brown c. ang. GRAVEL, little silt, trace c. sand, trace clay, occasional cobble 3" olive brown m. - c. GRAVEL and SILT, trace m. - c. sand, trace clay.
4-6	12	2" stiff brown-gray SILT, some clay, trace m. gravel. 6" gray SILT as above. 2"gray m. SAND, trace silt. 2" gray m. to c. GRAVEL (grn. and black siltstone and shale, round to subround); little m. sand, trace silt.
6-8	9	5" dark gray m. to c. GRAVEL, little m. sand and silt. (2½" siltstone cobble) 1½" damp dark gray SILT, some m. ang. gravel.
8-10	12	Slightly damp firm olive-gray SILT little m. - c. ang. gravel, trace clay. Bottom 2" grading slightly more clay.

TABLE 16 (continued).

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
10-11	12	Damp, olive gray SILT, little m. subang., gravel, little clay.
11-12	12	2" SILT as above. 1" SILT as above, little very f. sand. 9" SILT as at 10' - 11'.
12-14	14	SILT, as above. Bottom 2" grading little less gravel.
14-16	14	SILT, as above.
16-18	12	Firm olive gray SILT, some clay, little m. - c. ang. gravel, occasional cobble.
18-20	16	Damp, firm, compact olive gray CLAY, some silt, some m. - c. ang. gravel.
20-22	10	Damp, firm, compact olive gray CLAY, little f. - c. gravel, few large weathered s.s. cobbles.

Bottom of hole at 22'.
B. W. casing left at 20' to finish hole at later date.
Casing at L. S.

Figure 24.
GEOLOGICAL LOG OF CORE 80 - 10

Dark gray, organic silt; trace clay.

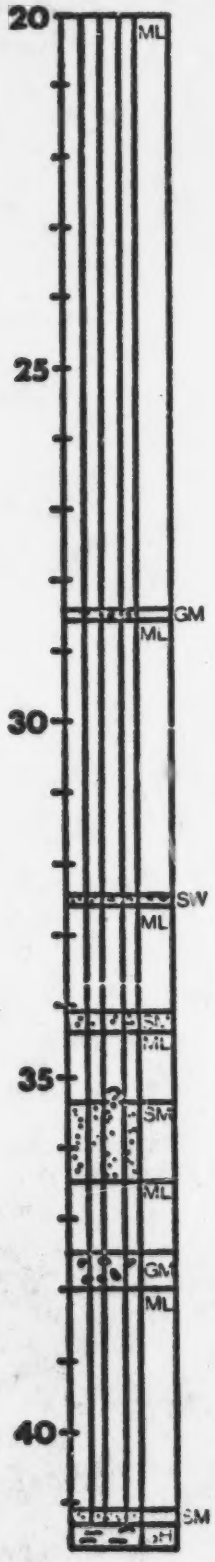
Mottled brown-orange, fine to coarse gravel; some silt; some fine to medium sand.

Brown silt; little fine to medium, angular gravel; trace sand; trace clay.

Gray-brown silt as above with occasional cobble.

Firm, olive-gray, unweathered silt; little fine to medium gravel; trace clay.

CONTINUATION OF GEOLOGICAL LOG OF CORE 80 - 10



Olive-gray, coarse, angular gravel; some silt.
Gray, damp, medium-firm silt; little fine gravel; trace sand.

(Saturated, well-sorted)

Gray, medium to coarse sand.

Olive-gray, well-sorted silt as above.

Gray, saturated medium to coarse sand; trace silt.

Gray, soft to medium firm silt as above.
Gray, saturated silt and medium to coarse sand.

Gray, moist, well-sorted silt.

Gray gravel and silt.
Gray, moist, well-sorted silt as above.
(Top 2 inches are loose and saturated)

(Grading to little medium to coarse gravel)

Gray, coarse sand; trace silt and fine to medium gravel.
Gray, dry, fissile shale.
Refusal at 41.7 ft.
Hole completed at 41.7 ft.
Groundwater at 28.4 ft.
Vertical scale 1:30

TABLE 17
Geologic Log of Core 80-10
September 30, 1980
Surface Elevation 1400.5 Feet

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
0-2	19	12" dark gray organic SILT, trace clay (topsoil), 7" mottled brown/orange f. to c. GRAVEL, some silt, some f. to m. sand.
2-4	11	4" GRAVEL, as above. 7" brown SILT, little f. to m. ang. gravel, trace sand, trace clay.
4-6	15	12" brown SILT, as above. 3" gray/brown SILT, as above.
6-8	10	5" gray/brown SILT, as above, little f. to c. ang. gravel, trace sand, trace clay, occas. cobble. 5" firm olive-gray SILT, little f. to m. gravel, trace clay.
8-10	24	2½" revovery from spoon: moist olive gray SILT as above. 18" recovered from cleanout spoon: olive gray SILT, some m. to c. gravel, little clay.
10-12	15	Damp, firm gray SILT, little f. to c. gravel, little clay, occas. cobble.
12-14	13	Damp, firm gray SILT, some m. to c. subang. gravel, little clay.
14-16	12	SILT, as above slightly more damp than above.

TABLE 17 (continued)

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
16-18	11	SILT, as above with some clay.
18-20	15	SILT, as above, little f. to c. gravel, little clay.
20-22	15	SILT, as above, moist.
22-24	10	Moist, very soft, sticky, olive gray SILT, some clay, little f. to c. gravel.
24-26	8	Moist, soft olive gray SILT, some clay, some m. to c. ang. gravel.
26-28	8	SILT, as above, though not as moist.
28-30	9	7" moist, soft olive gray SILT, some clay, trace m. to f. gravel. 2" c. ang. GRAVEL, some silt.
30-32	11	7" damp medium firm gray SILT, little f. gravel, trace sand. 4" firm, well-sorted gray SILT. Saturated good water yield.
32-34	16	7" moist, medium soft SILT as above. Poor permeability. 1" m. to c. SAND. 8" SILT as above, poor permeability
34-36	16	1" medium soft gray SILT, as above 2½" saturated m. to c. SAND, trace silt. 12½" damp soft-to-medium-firm gray SILT, as above.
36-38	18	6" saturated gray SILT and m. to c. SAND. 11½" moist gray SILT (no stone). ½" gray GRAVEL and SILT.

TABLE 17 (continued)

Depth Below Surface (ft.)	Core Sample Recovery (in.)	Description of Material
38-40	10	2" loose, saturated gray SILT. 5" firm, moist gray SILT. 3" firm, damp gray SILT, little m. to c. gravel.
40-41	15	3" soft, saturated gray SILT, trace f. gravel, trace clay. 5" soft saturated gray SILT, trace f. gravel, trace sand. 3" c. SAND, trace silt, trace f. to m. gravel. 4" dry, fissile gray shale.

Bottom of hole at 41' 8".
A. W. casing 41'8" to L. S.
A. W. casing and B.W. casing 30' to L.S.
Epoxy 41' 8" to 35'.
Bentonite pellets 35' to 5'.
Cement (Sakrete Mix) 5' to L. S.
Epoxy to L. S. in annular space between A. W. and B. W. casing.

Figure 25.

KEY TO GEOLOGICAL LOGS

GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
	GP	Poorly-graded gravels; gravel and sand mixtures; little or no fines.
	GM	Silty gravels; gravel, sand, and silt mixtures.
	SW	Well-graded sands; gravelly sands; little or no fines.
	SP	Poorly-graded sands; gravelly sands; little or no fines.
	SM	Silty sands; sand and silt mixtures.
	SC	Clayey sands; sand and clay mixtures.
	ML	Inorganic silts and very fine sands; clayey silts with slight plasticity.
	CL	Inorganic clays of low to medium plasticity; gravelly, sandy, or silty clays.
	OL	Organic silts and organic silty clays.

Classification based on the Unified Soil Classification System of the American Society for Testing and Materials..

APPENDIX D

RADIOCHEMICAL ANALYSIS OF WATER SAMPLES COLLECTED FROM THE LAGOON ROAD, SWAMP, AND FRANK'S CREEK STREAM MONITORING STATIONS

TABLE 18. Radiochemical Analyses of Water Samples Collected from Frank's Creek**

Date	Condition*	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
1/3/80	S.M.	<1.1	<4	<160
1/4	S.I.	<1.4	<6	540±29%
1/8	S.I.	<1.1	<4	210±65%
1/10	S.I.	<1.5	<6	250±55%
1/11	S.I.	<1.3	<5	140±95%
1/15	S.I.	<0.9	<5	210±65%
1/18	S.M.	<1.3	<6	200±81%
1/21	S.I.	<1.3	<6	170±79%
1/28	S.I.	<1.6	<7	<140
1/29	S.I.	<1.3	<6	250±54%
1/31	S.I.	<1.2	<4	250±55%
2/4	S.I.	4±98%	10±33%	190±92%
2/8	S.I.	<1.4	<6	<160
2/11	S.I.	<1.3	6±66%	240±57%
2/19	S.I.	<1.3	<6	220±04%
2/25	S.M.	<1.3	9±58%	220±71%
2/26	S.I.	<1.4	<7	320±47%
3/10	S.M.	<1.1	5±75%	230±68%
3/12	S.M.	<1.4	6±52%	230±73%
3/17	S.M.	<1.1	8±50%	260±63%
3/18	S.M.	<1.3	14±32%	<160
4/21	L.	<1.3	8±51%	260±60%
4/30	L.	<1.2	12±35%	170±89%
5/5	L.	<1.3	8±50%	<150
5/12	L.	<1.5	8±52%	200±75%
5/15	L.	<1.2	9±45%	170±87%
4/14	S.	<1.3	12±36%	210±59%
3/31	S.M.	<10	10±37%	260±62%
4/7	S.M.	<1.2	11±39%	240±52%
4/28	S.	3±98%	9±43%	140±87%
3/20	S.M.	<1.2	11±40%	420±38%
3/21	S.	<1.2	11±40%	310±51%
3/24	S.M.	<1.1	9±45%	290±56%
4/16	S.M.	<1.1	9±45%	200±63%
4/29	S.	<1.3	10±42%	200±62%
5/13	S.	<1.5	11±37%	220±59%
5/20	L.	<1.9	5±73%	140±81%
5/22	L.	<2	<4	200±59%
5/23	L.	<2	5±68%	<160
6/23	L.	<1.9	9±41%	150±80%
5/28	B.	<3	8±46%	<120

TABLE 18 (continued)

Date	Condition*	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
5/29/80	B.	<3	9±45%	210±55%
6/2	B.	<3	12±36%	<160
6/4	B.	<2	10±40%	200±61%
6/9	B.	<3	1±44%	190±63%
6/18	B.	<3	9±43%	170±70%
5/21	S.	<2	6±61%	190±62%
6/16	S.	<1.8	9±43%	300±41%
6/20	S.	5±79%	11±36%	---

Condition*

S.I. sub/supra ice
S.M. snow melt
S. storm
L. low flow
B. base flow

**For comparison, U. S. Public Health Service Drinking Water Standards relative to radiation are: 10 pCi/liter for water containing strontium-90, 3 pCi/liter for water containing radium-226, and 1000 pCi/liter gross beta activity.

TABLE 19. Radiochemical Analyses of Water Samples Collected from Lagoon Road

Date	Condition*	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
1/30/80	S.I.	<20	1510±9%	39000±7%
1/14	S.I.	<30	1330±10%	29000±8%
1/11	S.I.	<5	670±5%	40300±3%
1/23	S.I.	<30	2100±8%	36000±7%
1/22	S.I.	<16	1300±11%	32600±3%
1/18	S.M.	<3	780±5%	11900±4%
2/21	S.I.	<4	1030±49%	17500±7%
2/22	S.	<3	234±8%	6100±5%
2/25	S.I.	<3	570±5%	10000±4%
3/10	S.I.	<3	570±5%	17000±8%
3/17	S.M.	<3	168±10%	270±74%
3/18	S.I.	<3	510±5%	15500±8%
3/20	S.M.	<3	330±7%	2100±10%
3/21	S.	16±65%	540±5%	770±4%
3/26	S.M.	<3	340±7%	5900±5%
2/27	S.I.	<4	740±5%	280±68%
3/11	S.I.	<3	500±6%	8500±5%
3/27	S.M.	<3	470±6%	11200±4%
3/31	S.M.	<3	320±7%	5900±5%
4/7	S.M.	<8	1240±4%	27900±4%
4/16	S.M.	<4	800±5%	20300±4%
4/28	S.	<9	1990±4%	27300±3%
5/13	S.	40±54%	1240±5%	7500±5%
5/21		<5	770±5%	5500±5%
6/20	S.	<9	320±10%	1150±14%

Condition*

S.I. sub/supra ice
S.M. snow melt
S. storm
L. low flow
B. base flow

TABLE 20. Radiochemical Analysis of Weekly Composite Water Collected from Lagoon Road

Date	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
12/17/79-1/7/80	<30	300±25%	18200±8%
1/14 - 1/21	<20	1000±11%	26400±6%
3/17 - 3/24	90±65%	800±17%	4400±5%
3/24 - 3/31	<7	330±14%	4000±6%
3/31 - 4/7	<19	710±18%	12800±4%
4/7 - 4/14	<30	940±13%	---
4/28 - 5/5	<30	580±18%	9200±4%
5/5 - 5/12	<17	1430±10%	17100±3%
4/14 - 4/21	21±5%	730±5%	11500±42%
4/21 - 4/28	<16	1790±9%	37300±3%
5/12 - 5/20	<5	1510±4%	23100±3%
5/20 - 5/28	<5	1460±4%	20400±4%
5/28 - 6/5	<5	1360±4%	14700±4%

TABLE 21. Radiochemical Analyses of Water Samples Collected During Low and Base Flow Conditions at Lagoon Road

Date	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
4/22/80	<4	1430±4%	30300±3%
4/24	<40	1410±4%	41400±3%
4/30	<4	1080±4%	20300±4%
5/2	<2	1340±4%	31900±3%
5/5	<3	1540±4%	48700±3%
5/7	---	---	---
5/12	<3	1150±4%	41200±3%
5/14	---	---	---
5/15	<5	1700±4%	27700±3%
5/20	<6	1440±4%	34400±3%
5/22	<5	1600±4%	31200±3%
5/23	<5	1460±4%	32500±3%
6/4	<6	1280±4%	9500±4%
6/9	<5	1040±4%	16900±4%
6/16	<5	1020±4%	12800±4%
6/23	<6	840±5%	24600±3%
5/28	<4	1370±4%	30000±3%
6/18	<5	1110±4%	13300±4%

TABLE 22. Radiochemical Analyses of Water Samples Collected at the Swamp Monitoring Station

Date	Condition*	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	HTO (pCi/l)
1/14/80	S.F.	26±64%	50±18%	460±33%
12/17-1/7		<2	<12	680±26%
1/11	S.F.	<2	15±68%	300±52%
1/15	M.	<3	<13	550±32%
3/17 -3/24		<1.8	12±29%	480±37%
2/22	S.	<2	18±30%	630±29%
3/17	S.M.	<1.1	12±38%	340±47%
3/20	S.M.	<1.6	16±30%	500±34%
4/14 -4/21		<3	25±35%	1020±15%
3/31	S.F.	<1.7	13±32%	790±20%
4/14	S.F.	<11	49±24%	700±20%
3/29	S.F.	<2	22±22%	720±20%
5/21	S.	<2	12±41%	370±34%
6/20	S.	<2	13±31%	290±42%

Condition*

S. surface
S.F. subsurface flow
S.M. snow melt
M. mixed

APPENDIX E

RADIOCHEMICAL ANALYSIS OF SEDIMENT SAMPLES COLLECTED FROM THE LAGOON ROAD, SWAMP, AND FRANK'S CREEK STREAM MONITORING STATIONS

TABLE 23. Radiochemical Analysis of Sediment Samples Collected from Frank's Creek

Date	Condition*	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
1/3/80	S.M.	<7	<30	---
1/4	S.I	<7	<30	---
1/8	S.I.	<7	<30	---
1/10	S.I.	<6	<20	---
1/11	S.I.	<6	<20	---
1/15	S.I	<6	<40	---
1/18	S.M.	<7	<30	---
1/21	S.I.	<7	<30	---
1/28	S.I.	<8	<40	---
1/29	S.I.	<7	<30	---
1/31	S.I.	<6	<20	---
2/4	S.I.	12±98%	32±33%	0.3
2/8	S.I.	<6	<30	---
2/11	S.I.	<6	25±66%	0.2
2/19	S.I.	<7	<30	---
2/25	S.M.	<7	50±58%	0.2
2/26	S.I.	<8	<30	---
3/10	S.M.	<7	40±75%	0.1
3/12	S.M.	<9	38±52%	0.2
3/17	S.M.	<7	50±50%	0.2
3/18	S.M.	<6	70±32%	0.2
4/21	L.	<6	37±51%	0.2
4/30	L.	<6	70±35%	0.2
5/5	L.	<6	38±50%	0.2
5/12	L.	<6	32±52%	0.3
5/15	L.	<7	50±45%	0.2
4/14	S.	<6	53±36%	0.2
3/31	S.M.	<8	80±37%	0.1
4/7	S.M.	<6	60±39%	0.2
4/28	S.	14±98%	50±43%	0.2
3/20	S.M.	<6	60±40%	0.2
3/21	S.	<6	50±40%	0.2
3/24	S.M.	<7	60±45%	0.2
4/16	S.M.	<7	60±45%	0.2
4/29	S.	<6	47±42%	0.2
5/13	S.	<6	46±37%	0.2
5/20	L.	<8	20±73%	0.3
5/22	L.	<7	<14	---
5/23	L.	<7	18±68%	0.3
6/23	L.	<8	38±41%	0.2
5/28	B.	<8	20±46%	0.4

TABLE 23 (continued) .

Date	Condition*	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
5/29	B.	<8	21±45%	0.4
6/2	B.	<8	35±36%	0.3
6/4	B.	<8	34±40%	0.3
6/9	B.	<8	24±44%	0.04
6/18	B.	<7	26±43%	0.3
5/21	S.	<8	23±61%	0.3
6/16	S.	<8	41±43%	0.2
6/20	S.	18±79%	39±36%	---

Condition*

S.I. sub/supra ice
S.M. snow melt
S. storm
L. low flow
B. base flow

TABLE 24. Radiochemical Analysis of Sediment Samples Collected from Lagoon Road

Date	Condition*	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
1/3/80	S.I.	<30	1870±9%	0.8
1/14	S.I.	<30	1520±10%	0.9
1/11	S.I.	<6	920±5%	0.7
1/23	S.I.	<30	2340±8%	0.9
1/22	S.I.	<30	2600±11%	0.5
1/18	S.M.	<7	1600±5%	0.5
2/21	S.I.	<6	1760±4%	0.6
2/22	S.	<9	810±8%	0.3
2/25	S.I.	<7	1220±5%	0.5
3/10	S.I.	<7	1270±5%	0.4
3/17	S.M.	<10	660±10%	0.3
3/18	S.I.	<8	1390±5%	0.4
3/20	S.M.	<9	1090±7%	0.3
3/21	S.	23±65%	780±5%	0.7
3/26	S.M.	<8	890±7%	0.4
3/27	S.I.	<7	1450±5%	0.5
3/11	S.I.	<8	1280±6%	0.4
3/27	S.M.	<8	1150±6%	0.4
3/31	S.M.	<11	1350±7%	0.2
4/7	S.M.	<13	1880±4%	0.7
4/16	S.M.	<6	1160±5%	0.7
4/28	S.	<13	2660±4%	0.7
5/13	S.	31±54%	990±5%	1.3
5/21		<8	1300±5%	0.6
6/20	S.	<8	290±10%	1.1

Condition*

S.I. sub/supra ice
S.M. snow melt
S. storm
L. low flow
B. base flow

TABLE 25. Radiochemical Analyses of Weekly Composite Sediment Samples Collected from Lagoon Road

Date	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
12/17/79-1/7/80	<30	320±25%	0.9±25%
1/14 - 1/21	<30	1250±11%	0.8±11%
3/17 - 3/24	40±65%	310±17%	2.6±17%
3/24 - 3/31	<10	440±14%	0.8
3/31 - 4/7	<20	780±18%	0.9
4/7 - 4/14	<5	160±13%	5.9
4/28 - 5/5	<5	92±18%	6.3
5/5 - 5/12	<11	920±10%	1.6
4/14 - 4/21	29±5%	990±5%	0.7
4/21 - 4/28	<30	3100±9%	0.6
5/12 - 5/20	<8	2200±4%	0.7
5/20 - 5/28	<8	2100±4%	0.7
5/28 - 6/5	<8	2230±4%	0.6

TABLE 26. Radiochemical Analyses of Sediment Samples Collected During Low and Base Flow Conditions at Lagoon Road

Date	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
4/22/80	<6	2180±4%	0.7
4/24	<7	2380±4%	---
4/30	<6	1660±4%	0.6
5/2	<30	17200±4%	0.07
5/5	<7	3140±4%	0.5
5/7	---	---	---
5/12	<7	2420±4%	0.5
5/14	---	---	---
5/15	<6	2400±4%	0.7
5/20	<7	1890±4%	0.8
5/22	<7	2180±4%	0.7
5/23	<8	2200±4%	0.7
6/4	<8	1860±4%	0.7
6/9	<8	1650±4%	0.6
6/16	<8	15.0±4%	68.0
6/23	<8	1210±5%	0.7
5/28	<8	2540±4%	0.5
6/18	<8	1740±4%	0.6

TABLE 27. Radiochemical Analyses of Sediment Samples Collected at the Swamp Monitoring Station

Date	Condition*	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Sediment (g/l)
1/14/80	S.F.	24±64%	50±18%	1.0
12/17-1/7		<7	<40	---
1/11	S.F.	<8	50±68%	0.3
1/15	M.	<7	<30	---
3/17 -3/24		<8	53±29%	0.2
2/22	S.	<9	70±30%	0.3
3/17	S.M.	<7	70±38%	0.2
3/20	S.M.	<6	53±30%	0.3
4/14 -4/21		<7	60±35%	0.4
3/31	S.F.	<6	46±32%	0.3
4/14	S.F.	<12	53±24%	0.9
3/29	S.F.	<6	54±22%	0.4
5/21	S.	<8	50±41%	0.24
6/20	S.	<8	49±31%	0.27

Condition*

S. surface
S.F. subsurface flow
S.M. snow melt
M. mixed

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This is a report of the progress made during the first part of a proposed multi-year program of geologic and hydrologic investigations at the Western New York Nuclear Service Center. The New York State Geological Survey previously worked (1975-1979) on a small part of this area, specifically that of the New York State-licensed radioactive waste burial trenches. During the latest reporting period a large scale topographic map of the 140 hectare site immediately surrounding the nuclear fuel reprocessing plant has been produced, and three additional permanent stream stations have been installed to allow monitoring of most runoff from the site. Ten holes drilled in the North Plateau determined the geometry of the surficial gravel deposits there. A system of groundwater monitoring wells was established in these holes. The second phase of the geomorphic investigations of the Buttermilk Creek drainage basin and a study of the effect of submergence on the geotechnical properties of the burial till were completed.

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